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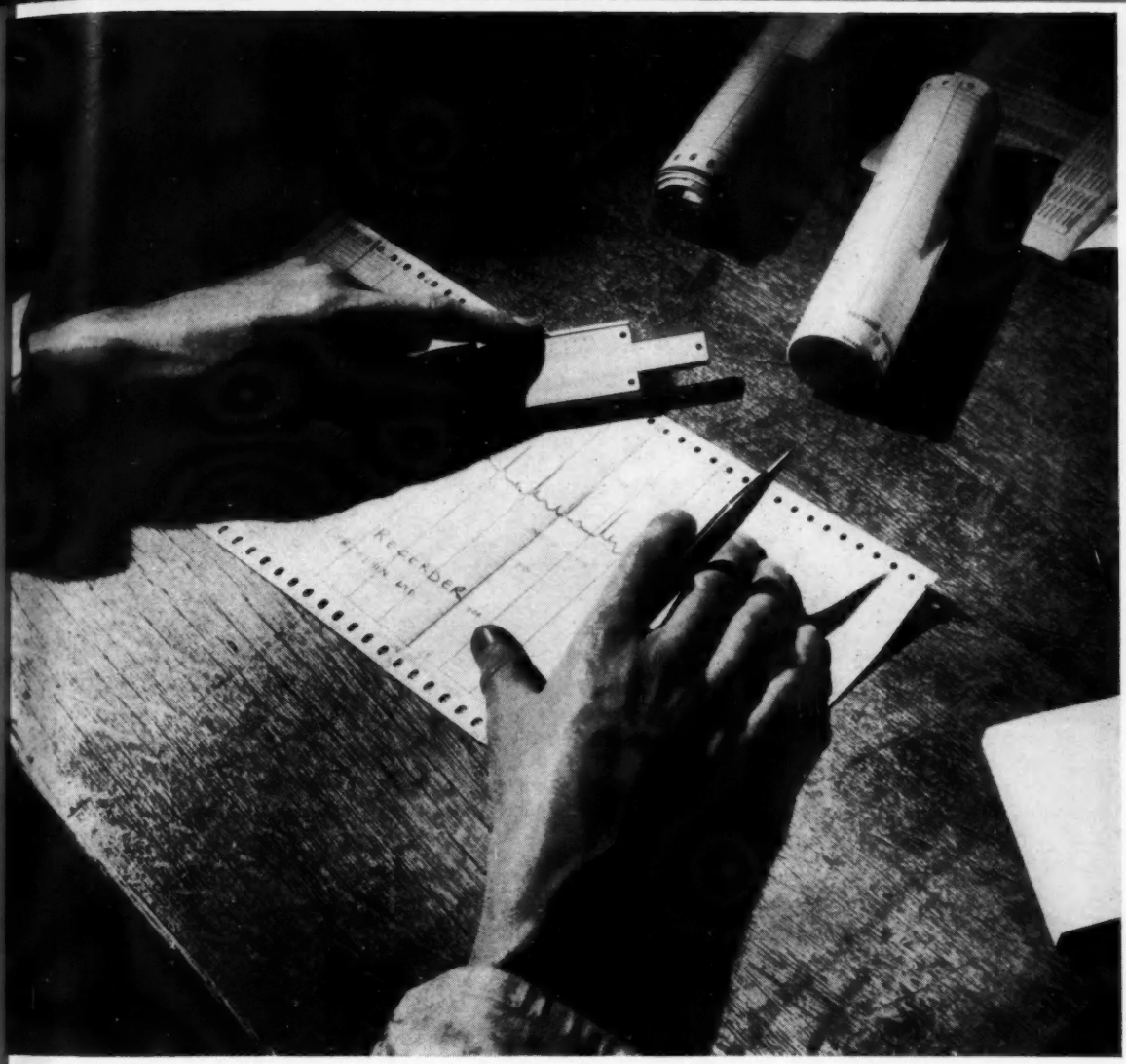

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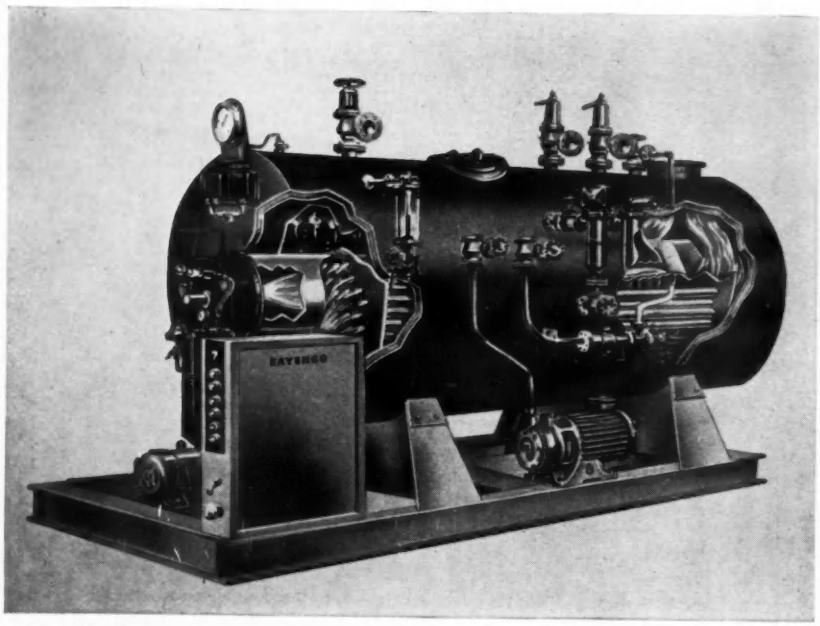

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GAS IN INDUSTRY

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FEATURES

HEAT TREATMENT—A SERVICE BY THE WEST MIDLANDS GAS BOARD
By Eric Ford.

FOUNDRY PROCESSES.
By J. Ward.

INDUSTRIAL GAS IN AN EAST ANGLIAN DIVISION —Part III. By R. F. Saggers.

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Editorial

Mastery in the Foundry

THE application of gas to foundry work is described in a paper published in this issue by Mr. J. Ward, Group Industrial Gas Engineer of the South Lancashire Group of the North Western Gas Board. Except for non-ferrous casting and the heat treatment of various forms of cast iron, it is clear that these applications are mostly of an ancillary nature, though nonetheless interesting for that.

Preparation of sand for the moulds and cores is of the utmost importance, and since this is essentially a drying operation followed by the curing of the cores, gas-fired equipment installed in the medium-sized and larger foundries carry out this work admirably. In fact it would seem that this operation and the drying and preheating of ladles is better done by gas than by any other heating medium. The old-fashioned methods of using solid fuel sand driers or lighting fires in ladles, or even of inverting them over an oil burner, seem crude in the extreme. The gas flame can be made to 'wash' round the whole internal surface of the ladle, and this particular method of drying has shown itself to be most economic. Tests have proved that unless due care is exercised costs of ladle preparation may easily amount to as much as one-third of the cupola costs.

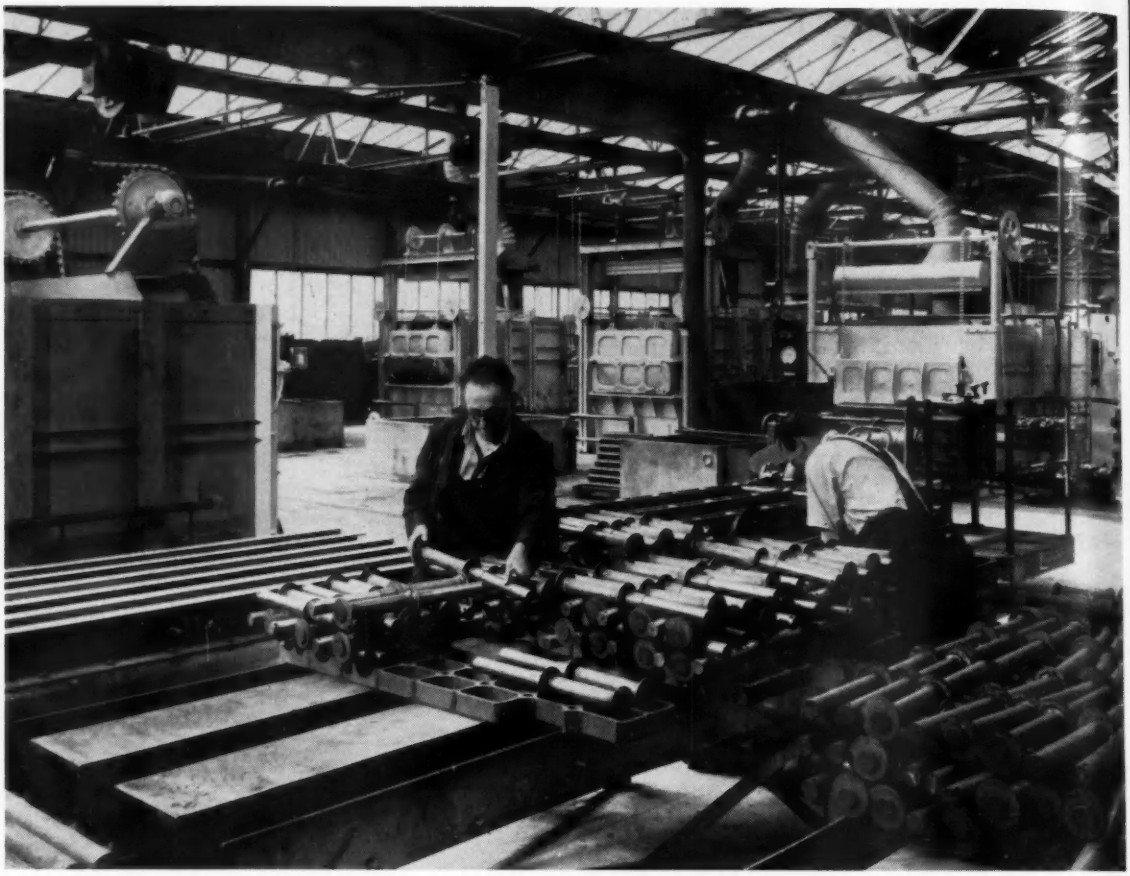
The application of gas to the lighting of the cupola itself is an obvious use of gas in the foundry, and from Mr. Ward's detailed description of the traditional way lighting up was done, the modified, somewhat enlarged, gas poker should be of great assistance.

The heat treatment of castings to improve their mechanical strength and the production of malleable iron by the 'whiteheart' and 'blackheart' processes by gas equipment introduces us to another set of processes. From which we pass easily to Mr. Eric Ford's article describing the Heat Treatment Centre at Adderley Street in Birmingham.

The Birmingham Gas Department were among the pioneers of the use of industrial gas and, to interest potential customers, started testing facilities for high pressure gas burners for industrial uses at the Windsor Street gasworks as long ago as 1911. At the same time furnaces were installed at the foundry where manufacturers could study the results of tests carried out on their own products under factory conditions.

This policy has remained and the work of the Industrial Gas Centre received considerable impetus during the two world wars. A move was made to larger premises at Brasshouse Passage in 1938, and as a result of the enormous increase in the volume of work during the second world war, it moved again in 1955 to Adderley Street.

There is no doubt that industrialists are taking an ever-increasing interest in the use of gas for heat treatment, but it is odd that so much of the actual process work should be carried out at the Centre by the Gas Board's own staff. It is considerably to its credit that so much confidence should be placed in the Board for the excellent designs of furnaces created by its engineers, and that its craftsmen should be considered capable of carrying out such specialised work.



Altogether, there are 22 furnaces in the Heat Treatment Section at the Adderley Street, Birmingham, works of the West Midlands Gas Board. Here is a general view of the Section, showing some of the equipment and, in the foreground, a small selection of the work which is handled by the service. The furnaces are well laid out in a spacious and well-lit building.

Heat treatment —a service by the West Midlands Gas Board

IT is well known that the contribution of an area gas board is far wider than the supply of an efficient form of energy for the industrial consumer to use in the operation of his business. In fact, in addition to maintaining the supply of gas, gas boards throughout the country offer a complete service of advice and research as well as design, manufacture and installation of equipment for specialised applications involving the use of gas. In some cases, the industrial workshops of an area gas board will undertake the actual production work on customers' behalf, for example, where heat treatment or other gas-fired processes are concerned.

These facilities are all offered at the highest level of competence by the Industrial Department of the West Midlands Gas Board which, from its Birmingham Headquarters, serves what is probably the most diversified industrial region in the United Kingdom.

These wide-ranging operations are carried on by the Industrial Department from two main centres in Birmingham, namely, the Headquarters building in Brasshouse Passage, where the design and development facilities include a drawing office, development laboratory and workshop, and the Heat Treatment Section in Adderley Street. It is the intention here to present a general picture of the operations of the Heat Treatment Centre, which has recently installed some important new equipment considerably widening the scope of the services it offers to local manufacturers and other industrial gas users.

Although the facilities available at the present Adderley Street site only date from May, 1955, the origins of the Heat Treatment Section can be traced back to pre-nationalisation days, when the Birmingham Corporation Gas Department was already well known as a pioneer in the field of industrial gas services. As long ago as 1911, an experimental foundry was laid down at the Corporation's Windsor Street gasworks, where tests were

carried out on high-pressure gas burners for industrial purposes and experiments conducted with new types of gas-fired equipment of all kinds.

Furnaces were installed at the foundry where manufacturers could study the results of tests carried out on their own products under factory conditions and thus decide whether to instal similar equipment in their own works.

During the first world war, the plant was employed on the heat treatment of such equipment as tank and aeroplane components and ammunition belts, and these activities, carried on under the stress of war, really led to the establishment of a specific Heat Treatment Section.

Between the two world wars, this Section steadily developed, undertaking production work for an increasing number of clients, both in the Midlands and further afield, in addition to tests for manufacturers contemplating the installation of gas-fired equipment in their factories and workshops.

So rapid was the expansion of the Section's operations that towards the end of 1938 it was moved to new and larger premises in Brasshouse Passage. Nevertheless, these premises proved inadequate to cope with the phenomenal demand imposed on the Section during the second world war, although the plant was employed at full capacity, working day and night for seven days a week, heat treating war material of all kinds. To satisfy the demand, two dispersal units, one provided by the Ministry of Supply, were staffed and operated by the Section.

With the ending of hostilities, it was clear that the work of the Section would continue at a high level and this has proved to be the case. Since nationalisation, the West Midlands Gas Board has extensively reorganised and expanded this important service, which was moved to Adderley Street in 1955.

Careful siting

A heat treatment shop was specially constructed, covering an area of more than 12,000 sq. ft., compared with the original melting shop (25 ft. by 40 ft.), in which the heat treatment operations had begun in 1911. The present heat treatment shop is spacious, airy and well-lit and the equipment has been sited on the shop floor with a careful eye to efficiency and ease of operation.

As a result, there is ample room for the necessary work associated with the operation, servicing and maintenance of the equipment and these functions are still further assisted by the numerous mechanical handling aids available, including overhead cranes, forklift trucks and roller conveyor systems. Furnaces are fed, and materials moved, as required, by a travelling charging machine of two-ton capacity. Roller conveyors are widely employed to move materials to the loading tables, while the forklift trucks ensure speedy and efficient loading and unloading of materials and equipment from lorries.

There are altogether 22 furnaces and ancillary pieces of equipment, including the latest addition, a gas-fired gas carburising furnace, which is one of the first of its kind to be installed in the Midlands. The other equipment includes a range of furnaces, comprising four with hearth areas of 8 ft. by 5 ft., two of 6 ft. by 4 ft., and others 3 ft. by 4 ft. and 3 ft. by 2 ft. In addition there are hot-air circulating furnaces for the solution treatment, annealing or ageing of aluminium alloys, stress relieving and annealing of other non-ferrous metals and tempering and stress relieving of ferrous materials.

Oil and water quenching tanks are provided and sited conveniently to the furnaces they serve. The oil tanks are connected to a cooling system and agitation of individual tanks is provided by separate pumps. Other new

By ERIC FORD

equipment includes an installation of salt baths for the isothermal treatment of tool steels and springs. The Section is well fitted to deal with the pack carburising of components of various types, a separate department having been set up at one end of the main workshop to facilitate the rapid and easy preparation of components for the pack carburising process.

While pack carburising is likely to continue to be employed in many applications, there can be no doubt that the addition of a gas carburising furnace to the plant at Adderley Street will widen the scope of the plant for this particular range of processes.

It is an atmosphere-controlled batch-type furnace manufactured by Gibbons Applied Atmospheres Ltd., of Birmingham and Thermic Equipment & Engineering Co. Ltd., Preston. It has been centrally sited in the heat treatment workshop, giving ample room in the front for loading, unloading and control while access for operation and maintenance at the rear of the equipment is equally satisfactory.

Controlled atmospheres, suitable for a variety of treatments, such as gas carburising, carbo-nitriding, clean hardening and carbon restoration, are supplied from the endothermic generator which is an integral part of the plant, forming its left-hand section. The endothermic atmosphere is generated from a mixture of air and propane in the ratio of approximately 7:1, which is then passed over a heated catalyst. The air/propane ratio has to be adjusted to ensure that no carbon dioxide or water vapour are formed or excess carbon deposited on the catalyst. The plant is so arranged that this basic atmosphere gas can be enriched with propane for gas carburising or with propane and ammonia for carbo-nitriding. This generator is capable of delivering endothermic gas at the rate of approximately 500 cu.ft. per hour.

A neat control panel is built into the front of the generator, incorporating flow gauges and gas pressure gauges. The endothermic gas supply from the generator passes through a mixing tee at the top right-hand corner of the control panel where a fine control valve is fitted for the adjustment of the enriching gases.

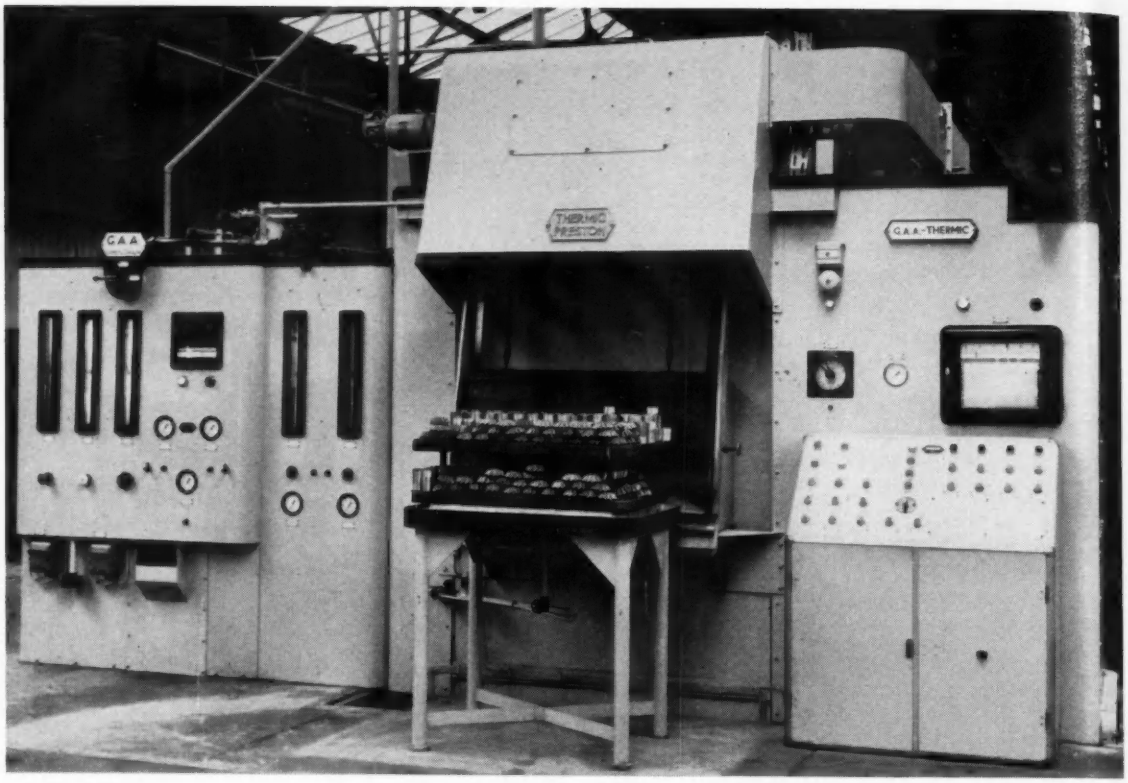
With a maximum height of 12 ft. 3 in., the furnace has an overall length of 13 ft. and an overall width of 11 ft. 3 in. It will accommodate a charge measuring 3 ft. wide, 2 ft. deep and 1 ft. 6 in. high, has a doorway opening 3 ft. 6 in. wide and a heating chamber 3 ft. long. The loading height of the chamber is 3 ft. above floor level. The equipment has been designed to give a maximum output, when clean hardening, of 500 lb. per hour.

Essentially, the furnace comprises two separate chambers, namely, the hot zone and a water-jacketed discharge vestibule. The furnace proper is fired by five gas-fired recuperative nickel chrome radiant tubes, arranged two at the top and three at the bottom of the working chamber. The maximum burner capacity is 2,000 cu.ft. per hour, with an average working consumption of approximately 1,000 cu.ft. per hour.

Push-button

A two-station loading and quenching elevator is housed within the vestibule, which is continually purged with the furnace atmosphere. The lower station is always used for quenching and, generally, the upper station for loading. This procedure enables the waiting charge to be pre-heated and to be immediately available for loading when the furnace charge is withdrawn and quenched.

All the operations of the furnace are power-operated by push-button control. The vestibule door lifts upwards to allow for the admittance or removal of work, the upward movement of the door causing the ignition of a gas curtain through a pilot



A general view of the G.A.A.-Thermic gas carburising furnace which was recently installed in the Heat Treatment Section of the West Midlands Gas Board. The gas-fired furnace is flanked on the left by the atmosphere gas generator and on the right by the control facia and instrument panel.

burner beneath. The inner furnace door is power-operated as are the charge racks and quench elevator.

A built-in oil quench tank is situated below the vestibule and the associated oil quench circulating pump and cooler has a total capacity of 600 gal. per minute.

A complete sequence of operations commences with the opening of the inner furnace door and the exit of the rack containing the completed work, which is then deposited on the elevator rollers at this level. The empty rack now returns to the furnace and the door is closed.

As the power-operated quench elevator lowers the hot charge into the quench, the new charge (which has been pre-heating meanwhile in the upper station of the vestibule) is brought down to the furnace level. Once again the inner furnace door is opened and the rack withdrawn to collect the pre-heated charge. The rack and charge are next returned to the furnace and the door is closed.

An operative demonstrates the method of loading the gas carburising furnace. When in operational use, a gas curtain, ignited by a pilot burner sited below the opening, effectively seals the furnace opening.

Control desk

At this point, the vestibule door is opened and the gas curtain immediately seals off the vestibule from incoming cold air. The new charge, set up on a nickel chrome grid, is pushed into the vestibule on to the rollers of the upper station of the elevator which is then raised, bringing the quenched charge to the level of the vestibule door, whence it is withdrawn and the vestibule door closed.

These operations are all initiated from a control desk which is conveniently sited on the right of the plant, the facia of which comprises

the necessary push-buttons and indicator lights associated with all the powered operations of the furnace.

Each operation of the furnace which is effected from the control panel, i.e., all the charging, discharging and quenching operations, is indicated by signal lights. The instrument panel above the facia of the desk incorporates automatic furnace temperature recording control, timing device and oil temperature indicating thermometer. Atmosphere control is effected by dewpoint measurement in the furnace chamber and it is thus possible to vary the atmosphere gas.

Experience

Thanks to the work of the Department's staff of experienced heat treatment engineers and metallurgists, considerable experience has already been gained on the operation of this new furnace, which has proved its value in a series of tests on a variety of heat treatment processes.

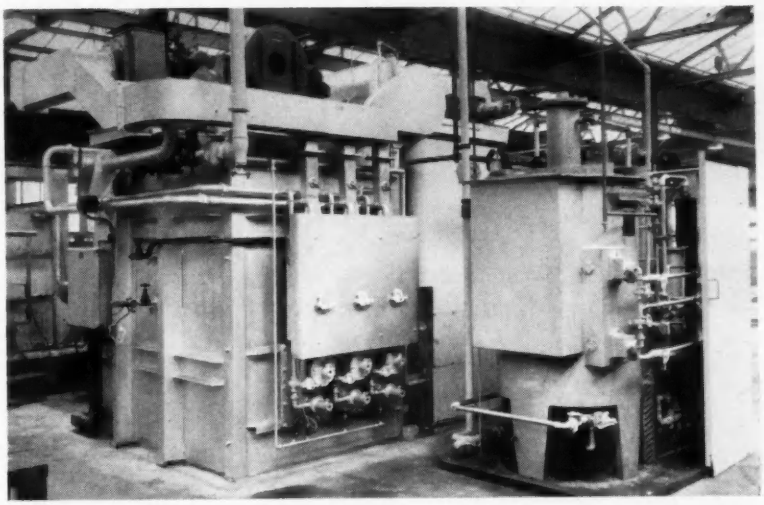
In order to test the equipment more thoroughly still, and also to demonstrate its operation to manufacturers who may be contemplating installing a similar furnace in their own works, the Heat Treatment Service of the West Midlands Gas Board is open to receive orders from clients in any part of the country for the gas carburising, on a commercial basis, of such items as crown wheels and pinions, gears, cams and cycle components and also the clean hardening and tempering of special die blocks, machined parts and similar items.

At the same time, industrialists, plant engineers and others who are considering installing plant of this type will be able to see it in operation, knowing that the work passing through it is being treated on a completely commercial basis.

This facility of seeing gas-fired equipment at work under normal production conditions is by no means an innovation so far as the Heat Treatment Service is concerned, as many hundreds of satisfied clients from centres as far apart as Scotland and Cornwall know full well. Heat treatment work of this nature has been carried out by the Service for some 40 years past.

Varied activity

Items treated in any one of the score of furnaces operated at the Section range from quite large components such as turbine equipment for jet engines, components for hydro-electric and thermal power generating stations, down to tiny springs and washers for such applications as vehicle windscreen wipers. This variety of product is a natural reflection of the varied industrial activity of the Midland area which the Section primarily serves.



A rear view of the gas carburising furnace showing, on the right, the atmosphere gas generator and, beside it, the furnace. The three radiant tube burners, firing at the bottom of the working chamber, can be seen. Two more similar burners firing at the top of the chamber are behind the metal plate.

At any given time, as many as 200 different products may be passing through the plant, for gas carburising, pack carburising, normalising and annealing, hardening and tempering, solution treatment of non-ferrous alloys and scale-free hardening of high-speed tools. Some orders may be of the one-off variety while others may comprise bulk quantities from clients who regard the Section as almost an extension of their own production line. Propeller shafts for heavy lorries are regularly processed at the plant as are main axles for motor buses which are subjected to heat treatment which increases the tensile strength to 65-70 tons per sq. in.

About 50% of all materials handled at the Section are for the aircraft industry, ranging from small engine parts to main drive shafts for turboprop engines. With the increasing demand for specially treated metals for jet engines the Section is finding

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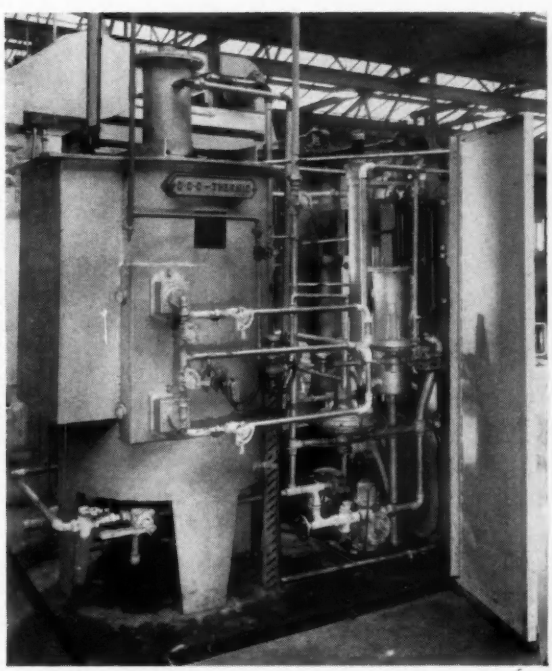


A close up of the atmosphere gas generator which is associated with the gas carburising furnace. Propane is piped from bottles kept in a nearby store place.

FOUNDRY PROCESSES

Ways in which gas can assist new techniques

DURING the last few decades iron casting has developed very rapidly. Mechanisation and many new techniques have given greater productivity and at the same time castings have tended to become lighter for a given strength. The purpose of this paper is to highlight the processes in modern foundry practice where town gas is playing, and can still further play, an important part as a heating medium.

The basic commodity for foundry moulds is a clay-free silica sand. 'New' sand must be dried to ensure a more intimate mixing between the sand and the bonding materials. Drying is especially important in the preparation of core sands.

Special plant

Small foundries often spread the sand out on plates, cast moulds, the top of core stoves or any place where there is a heat source. In larger foundries special drying plant is required and although solid fuel has been—and still is—a widely used heating medium, there is a very good case for gas in modern foundry practice. Indeed, there are many gas-fired driers of both the 'static' and 'rotary' type in use and giving every satisfaction.

The static drier consists of a sand hopper mounted over a combustion chamber; the dry sand running out at the base of the hopper where it can be collected as required. The main disadvantage of this arrangement is clogging of wet sand in the hopper. In the rotary dryer wet sand is delivered from an overhead hopper on to a feed table and then swept off into the rotary drum drier by means of a fixed plough. The hopper is vibrated from time to time to prevent clogging of the wet sand. The sand is dried by cascading through the drum, which is slightly inclined from the horizontal, around a centrally located tube which is slotted and extending the full length of the drum. Heat is supplied through the tube either by means of a bar burner or preferably from a direct-fired air heater with recirculation. As the sand is not affected by a high temperature, counter flow drying may be used. Cost per ton of sand dried will, naturally, depend on initial moisture content, but gas is competitive with solid fuel if maintenance, labour and depreciation are taken into account.

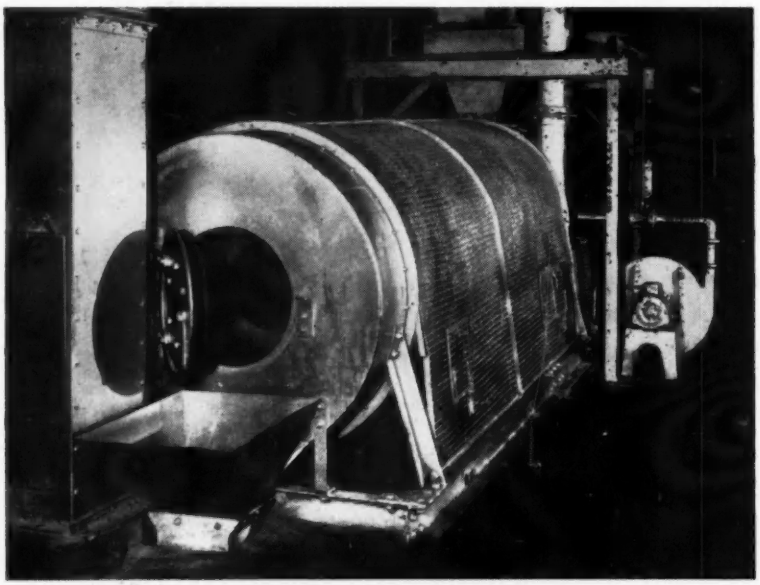
Although foundry moulds may be cast 'green,' *i.e.*, without any drying, it is essential that the sand should be sufficiently strong to withstand the pressure of the hot metal and this is achieved by drying the mould. There are three methods of drying: (a) Torch drying, when it is only considered necessary to dry to a depth of 2 in. or less from the mould face; (b) hot-air drying, which may be used for complete or skin drying, and (c) complete drying, carried out in a stove or drying chamber. We will consider them in reverse order.

The early types of stoves consisting of simple brick chambers heated by placing coal or coke braziers inside, or later superseded by solid fuel grates built at the rear of the chamber, gave erratic results. Many have been converted to gas, either by firing into the existing combustion chamber, installing natural draught burners down each side of the stove, or by a direct-fired air heater with recirculation. The latter method is to be preferred.

The heavy box moulds, where sand of high moisture content and low permeability is used to produce the necessary moulding properties, the moulds are run into the stove on bogies and drying extends over a period of 12 to 48 hours at a temperature of around 300°C., depending on the weight of sand in the moulds.

Various methods have been used to dry large floor moulds or those which are difficult to handle or accommodate in a stove are dried *in situ*. In the past coke braziers were hung over the mould, but this was a very inefficient and lengthy process, and created an unhealthy and sometimes dangerous atmosphere in the moulding shop. Various alternative methods have been tried, including bar burners and infra-red, but it is now generally accepted and recommended by recent Joint Standing Committees that hot-air forced circulation from portable unit driers is the best. Innumerable tests have been carried out on coke-fired units and a full series on one gas-fired unit. The report states that up to 1.9 in. w.g. back pressure the production of CO was substantially lower than with the coke-fired appliances under all circumstances.

A good many gas-fired driers are in use but they are mainly very large and



A manually-operated horizontal sand drier capable of drying two tons of sand an hour, used at a locomotive works.

by

J. WARD

Assoc.M.Inst.Gas E.,
Assoc.M.Inst.F.

EAST LANCASHIRE GROUP
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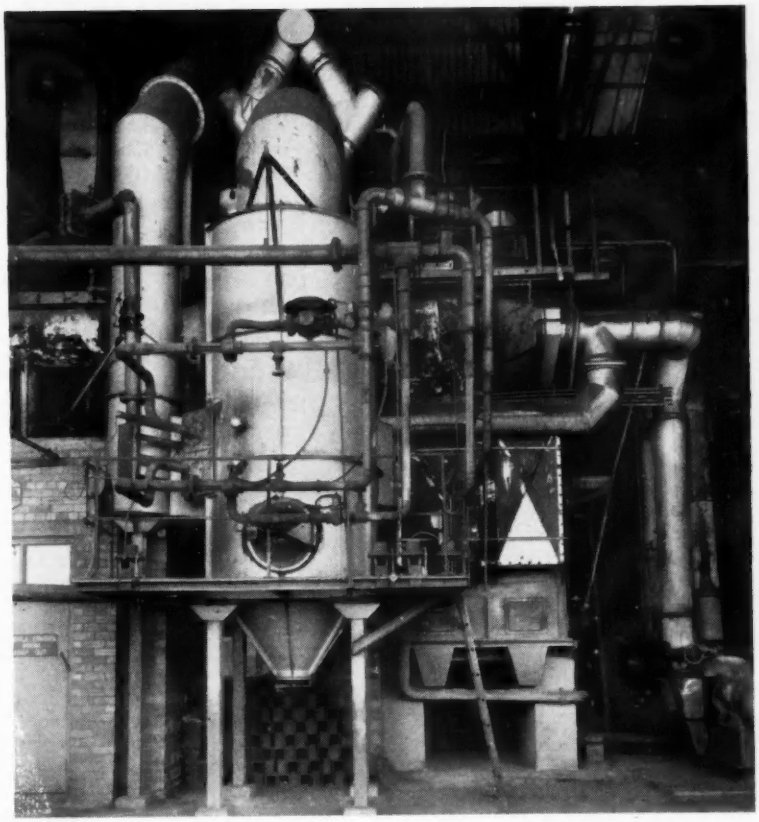
ENGINEER,
NORTH WESTERN BOARD



A view of the combustion chamber of a hot blast cupola plant, showing gas and air pipes used for pre-heating the chamber and retaining heat during shut-down periods. The combustion chamber is part of a recuperative system for supplying hot blast at 500°C. to eight-tons-an-hour water-cooled cupolas. Each of the four gas burners uses about 3,500 cu.ft. an hour.

more suitable for the larger foundries. To meet the need of the small and medium-sized foundry we have designed a much smaller unit which can be easily moved by hand and is relatively inexpensive.

Drying by the torch method is usually confined to moulds smaller than the above but too large to be cast 'green.' Torches using gas of a fairly low c.v. are used and town gas is widely preferred.

In order to produce castings having internal shapes, undercut contours or isolated hollow pockets, it is necessary to use sand shapes or cores. These are carefully located between the two half-moulds on a seating which has been allowed for in the pattern and thus the molten metal can be poured through prearranged runners into the cavity between mould and core.

Cores are made from various types of sand and bonding agents and extreme care must be taken to ensure that the core fulfils all its required functions. The core should allow the metal to flow smoothly, resist erosion of the metal, allow every cavity to be filled and maintain its shape long enough to allow the metal to freeze. It should also allow for contraction and, as solidification of the metal takes place, partial disintegration of the core must proceed simultaneously. Finally, they should be capable of being removed from the casting with minimum effort and without damaging the casting.

Exacting process

The art of core making is, in fact, a very exacting process and it is equally important that the drying operation is carried out in like manner. The drying of cores fulfils two purposes; (1) the driving off of all moisture and gases so that they will not be evolved during casting and cause blowholes, and (2) the baking of the core to render it firm and hard enough to stand up to handling, stores and casting.

The fundamental factors to be observed in core drying are—(a) that the cores must not be dried too quickly or they will bake on the outside while the centres remain moist, and (b) that the temperature must not be too high or the cores will be burned and collapse.

Drying temperatures vary with the type of core and binder, size of core, oven used and time available. Core drying stoves must be designed to allow oxidisation of the oil in the core and complete evaporation of the moisture. Hot air must be freely circulated around the core to supply the oxygen which will cause the oil in the core to become a thin, hard film and thus create the strength of the core. The circulation also causes the steam from the moisture in the core sand to escape.

The type of stove, dependent on class, size and quantity of cores normally used in any particular foundry, can be classified under two main heads.

1. Batch type or continuous.
2. Heated by natural convection or forced circulation with or without recirculation.

Converted

The early type of batch oven was of brick construction and similar to the one described under mould drying. Modern batch type ovens are designed to accommodate trolleys on which the cores are stacked and drying is carried out by means of an external gas-fired air heater with recirculation. Temperature control and recording apparatus is now usually employed. Small cores which are mass produced are usually dried and cured in a continuous vertical oven of the swing tray variety. Many have been converted from solid fuel to gas-firing and are operating at greater efficiency and a reduced stoving time. Indeed, the trend is towards higher drying temperatures with accelerated speed of recirculated hot gases. This

promotes greater penetration of the permeable cores and so oxidises the binder well beneath the surface.

During the war the Germans developed a process known as shell moulding, which consists of 'dumping' or pressing a mixture of fine silica sand and phenol formaldehyde resin upon a hot metal pattern. The resin softens with the heat and flows with the sand to the contour of the pattern. In something less than half a minute the shell of sand and partly-cured resin is built up on the pattern surface, excess sand and resin is removed and the shell and pattern placed in an oven to complete the curing. The hard shell from the pattern can then be removed in one piece and two such shells stuck or clamped together face to face produce the mould cavity into which molten metal may be poured. After casting, the heat of the metal burns out some of the resin, but the mould holds together long enough for the metal to solidify.

Shell moulding machines may be hand operated, semi-automatic or fully-automatic. The fully-automatic machine suitable for mass production on a large scale may have 12 or more stations and an output of hundreds of complete shells per hour. The hand-operated machine, however, is limited to small scale repetition work, but the most popular machine in this country is probably the semi-automatic machine where the operator manipulates two or more buttons or levers in turn. The pattern plates and ovens of these machines can be heated by electricity, bottled gas or town gas, but there is no reason why the majority should not be town gas. Foundries either have a piped supply for other purposes or a service could, in most cases, be provided. On the basis of operating cost there can be little doubt that town gas is the most economical.

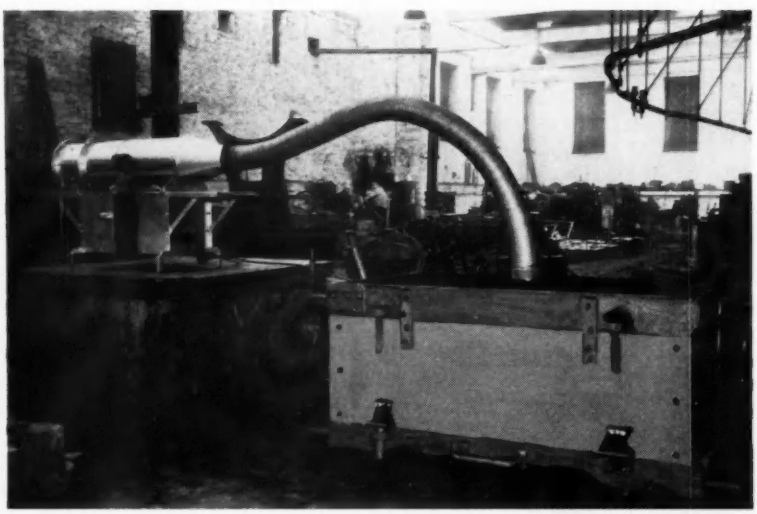
The basic technique of moulding by the 'lost wax method' has been practised by jewellers and dentists for a long time, but it is a very slow process and only suitable for making articles in small numbers.

During and since the war, however, this basic technique has been developed and modified in such a way that mass production methods can be employed. Precision-type castings up to about 7 lb. in weight, of very complex shapes and in a wide range of metals can now be manufactured.

The process consists of pouring a finely graded refractory slurry into a special container, within which has been mounted a wax replica of the casting required. This wax replica is thus completely embedded in the refractory investment, and the latter is allowed to dry. Small passages are provided through the wall of the investment to act as outlets through which the wax may be evacuated, and as feed runners for the metal.

The investment mould is now ready for heat treatment the basic principle of which is initial drying at low temperature followed by the melting out of the wax. The furnace used may be continuous or of the batch type; the temperature is increased from room temperature to 600°C. relatively slowly, after which the moulds are fired at temperatures varying from 1,000° to 1,200°C. In most cases, the moulds are taken directly from the furnace while at temperature for the casting process, but in a few instances the moulds are allowed to cool prior to the casting operation. When the casting has solidified and cooled, it is removed by breaking up the investment mould.

The batch firing of moulds is usually carried out in natural draught semi-muffle furnaces, which can be hand controlled, automatic temperature controlled or programme controlled. On hand control it is usually found that if the gas is governed down to a low enough pressure to give a consumption a little higher than the maintenance rate at 1,100°C. the furnace temperature will slowly climb up to final value over a period of 10 hours with its charge.



A view of a N.W.G. Axial-Jet B air heater in use at a Blackburn foundry drying a floor mould. About 1,000 cu.ft. of gas is used to dry in 4½ hours 15 cwt. of wet sand; a solid fuel oven usually takes about 16 hours to do this.

Continuous furnaces

A number of works have installed continuous furnaces where continuity of production has been established. In these furnaces the charge end is slowly preheated by the waste gases from the high temperature section and the temperature slowly built up to 600°C. prior to the final heating zone which, as previously described, may be between 1,000°C. and 1,200°C. With continuous furnaces it is essential to ensure that the last station maintains the moulds at the final firing temperature.

Although a variety of melting methods are employed in foundries the cupola furnace is used almost exclusively for the melting of cast iron.

The cupola consists of a cylindrical steel shell mounted in an upright position on a base plate which originally was built on a brick foundation. Many of this type are still in use today, and are known as 'solid bottom' cupolas. Modern cupolas are mounted on steel joists or tubular columns and provided with hinged doors in the centre of the base plate which allows for easy removal of debris at the end of each melt. A wind belt or blast box, 2 ft. to 5 ft. in depth, is provided at a height of 2 ft. to 3 ft. above the base plate and completely surrounding the shell. Air is supplied from a fan or Roots blower, and the blast conveyed to the furnace interior through tuyeres (*i.e.*, nozzles) situated in or under the wind belt.

In a drop bottom cupola the working base is made up with moulding sand through a 'fettling hole' located at the bottom of the shell. This hole is used on solid bottom cupolas for raking out debris at the end of a melt and is usually about 18 in. square and covered by a plate held in position by a bar during melting operations. A metal 'tap hole' is located at the front of the furnace and the sand base is arranged to slope towards it. A 'slag hole' is provided about 9 in. below the centres of the tuyeres and the

charging hole is provided at a height of 12 ft. to 15 ft. above the tuyeres or it may be 20 ft. on very large cupolas. Linings employed in cupolas may be firebrick or plastic refractory rammed up *in situ* and dried carefully and the thickness is usually 9 in.

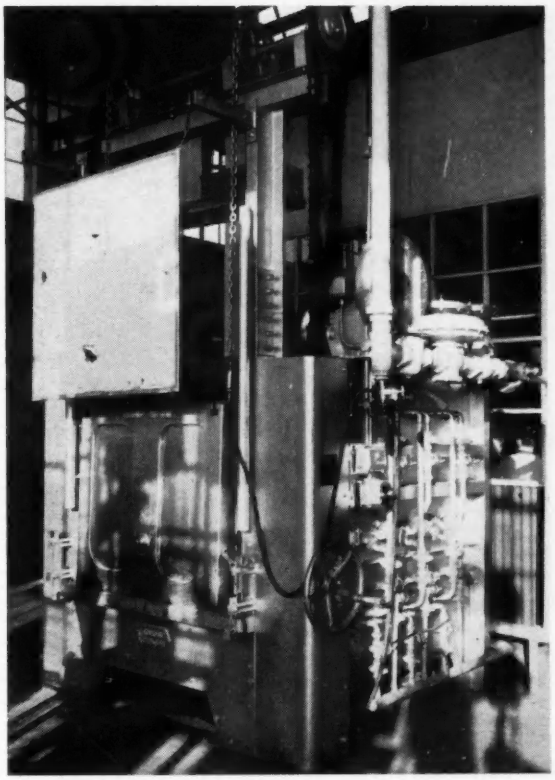
A fire is first lit in the cupola on the working bottom and usually consists of rags soaked in paraffin with about 1 cwt. of wood. Coke is added in small amounts until the fire reaches the tuyeres after which it is drawn up by natural draught air for combustion being admitted through the open fettling and slag holes. When the coke is well alight the fettling hole is sealed with sand and covered with the steel plate. The coke bed is now built up to its final level and when conditions are satisfactory, alternative charges of metal and coke are added until the level of the charging hole is reached. The flux charges, usually limestone, are added with the coke. With the cupola charged, the full air blast is turned on. After several minutes the molten metal begins to flow, and collects in the well until there is sufficient for a 'tap' to be taken. In the meantime, alternative charges of metal and coke are added to replace metal as it is melted. 'Slag' is removed at appropriate intervals to prevent a build-up in the cupola. Apart from the cost of firewood lighting by this method suffers from the disadvantage that, as the rags and wood burn away, the whole charge drops with prejudicial effects on the final product.

Gas-fired torches

Gas-fired torches have been used very successfully for many years for cupola lighting and can be made up from a standard air-blast gas mixer and a length of mixing tube with fish-tail head. Gas and air lines are of flexible tube suitably reinforced and securely fastened.

In laying the fire a tunnel is arranged in the coke bed to receive the poker. The poker is lit and inserted in the tunnel. After 10 to 20 minutes the coke is well alight and normal furnace procedure, already described, is continued.

The Selas Gas & Engineering Co. Ltd. manufacture a range of gas torches to suit every size of cupola. These are to be preferred since they are equipped with a special heat-resisting steel fish-tail burner head and designed for use with either high or low pressure air.



A Thermic batch-type furnace for firing moulds after drying in the lost wax investment process at Rolls-Royce Ltd., Crewe.

The following test was carried out with a Selas lighting torch, type No. 271/1. on a Cupola of 4 tons melting capacity per hour. The maximum rate of town gas consumption was 400 cu. ft. per hour and the air for combustion was taken from the cupola compressor at 14-in. w.g. The fuel bed was originally laid to a depth of 24-in. The average time taken for the combustion of the coke in the fuel bed to attain a sufficient level to proceed natural draught conditions was 15 minutes with an average total consumption of 100 cu. ft. of gas.

Coke in the cupola serves two main purposes. First, it provides the heat for melting—and superheating—and secondly, it provides a reducing atmosphere for the metallurgical reactions between metal, slag, coke and gases.

When the blast air is pre-heated, there is a higher combustion temperature in the cupola, which produces a higher CO content in the products of combustion and gives a greater reducing atmosphere where the iron is melted and superheated. Under such conditions, the iron melts faster, metal temperatures are higher, and metallic losses by oxidation are lower.

Although there is some doubt whether the cost of installing and operating the necessary equipment for preheating the blast can be justified on melts of less than 5 hours duration, it is clear the advantages are very real and desirable.

There are three methods by which the air may be heated:

1. By passing air through an arrangement of cast iron pipes embodied in the cupola just above the melting zone.
2. Heating the air by means of an external stove which can be either coke or gas fired.
3. Using the waste gases from the cupola which are rich in CO to heat the air passed through a recuperator.

In two large installations in the North Western Gas Board area by Cupodel, Ltd., the third method is used together with town gas burners for supplementary pre-heating and large ignition pilots.

The advantages claimed for using pre-heated blast are that (a) a larger proportion of scrap may be used, (b) there is a reduction in the amount of coke used, or alternatively that temperatures are higher, (c) there is a

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This article is based on a paper to the eighth general meeting of industrial gas engineers at Manchester Industrial Gas Development Centre.

reduction in labour, (d) the castings are of better metallurgical quality and (e) there are savings in refractories and maintenance costs.

The ladles used for conveying the molten metal into the moulds are an essential item of equipment in a foundry. They vary in size according to the job they have to do. Large ladles, *i.e.*, over 10 cwt. capacity have refractory linings, the type depending on the size of pot, and character of the metal. The lining must be absolutely dry before any hot metal enters the ladle, since the smallest trace of moisture will be quickly converted to steam which will eject molten metal from the surface. Both lined and unlined ladles should be heated to prevent chilling of the metal and for obvious reasons all newly lined ladles should be thoroughly dried before use.

Method superseded

Sometimes it is more convenient to transfer molten metal from large ladles to smaller ones for pouring into the moulds, and it is equally important that these mild steel ladles or 'shanks' are properly dried.

To-day the old method of lighting solid fuel fires in ladles or hanging braziers inside them has been largely superseded by gas torches. These may be tailor-made to suit any type and size of ladle or obtained from manufacturers who supply a wide range.

For the smaller ladles, torches similar to those used for cupola lighting are very suitable but the larger ladles require a good deal more than a single flame and special provision must be made for lifting and lowering these camparatively heavy burners.

The Selas Gas and Engineering Co. Ltd., supply a very good unit suitable for drying ladles of from three to 60 tons capacity. For smaller ladles The Thermic Equipment and Engineering Co., Ltd., supply a compact, robust burner mounted on a pedestal and equipped with lifting and lowering gear.

Figures have been published from time to time giving costs for ladle heating. In a paper by J. A. Grainger of Hadfields, Ltd., to the Combustion Engineering Association in Sheffield recently, it is emphasised that without proper precautions ladle heating costs can be as much as $\frac{1}{3}$ of the cupola melting cost. The author goes on to prove by test results that gas heating is $\frac{1}{2}$ to $\frac{2}{3}$ the cost of oil heating and attributes this mainly to the fact that a gas flame can be projected right inside the ladle and allowed to 'wash' over the refractory surfaces.

Tests carried out at a foundry in Oldham with a Thermic ladle drying unit gave the following results:—

The maximum gas rate at a governed pressure of 3 in. w.g. was 150 cu. ft. per hour.

In test 1, a ham shank (11 in. by 11 in.) was dry in 15 minutes, in test 2, a ham shank (11 in. by 11 in.) was dry and preheated to 920°C in 35 minutes and in Test 3 a 24 in. dandy was dried in 30 minutes.

There are a number of heat treatment processes which if applied to cast iron, improve its mechanical properties. In addition to case hardening and tempering, they include stress relief annealing, and the reduction of the carbide content to improve machining.

Gas-fired furnaces are eminently suitable for these processes, since close control over the heat treatment cycle is very important. Where large tonnages are involved, the continuous bogie hearth furnace is most suitable because it can be designed with three zones, *i.e.*, heating up, soaking and cooling.

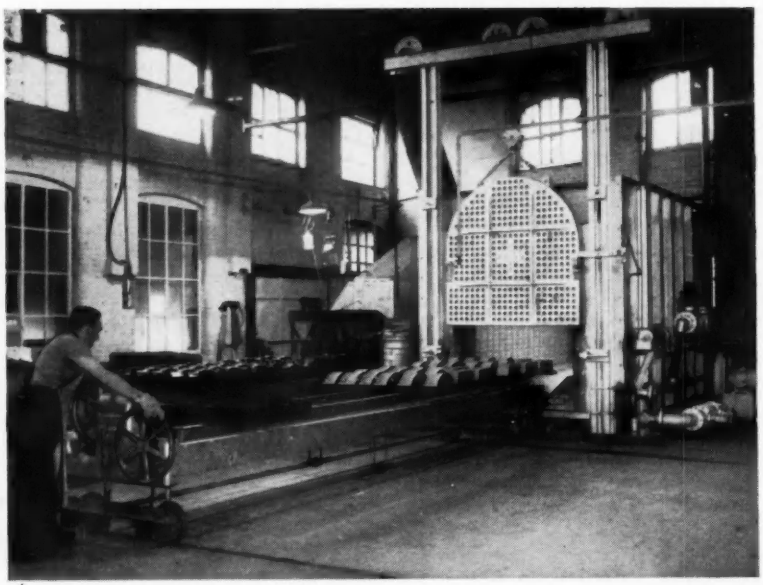
In 1948 the British Cast Iron Research Association announced a method whereby the graphite present in ordinary grey cast iron could be made to assume a spheroidal form on solidification by treatment with cerium, and shortly afterwards others in America achieved the same purpose using magnesium.

A paper presented to the Manchester District Junior Association of Gas Engineers in 1956 by H. C. Ellis described how this new form of cast iron is being treated at a firm in Birkenhead to develop its maximum physical properties. The author described the plant as follows: 'The plant used is a portable cover furnace by Dowson and Mason Ltd. and measures 11 ft. long by 5 ft. 3 in. high, internal dimensions. The burners, located, all round the base, are supplied with gas and air, through linked motorised valves, in fixed proportions, the air being preheated in recuperators extracting heat from the lower horizontal flue. Temperature control is effected by a portable thermocouple thrust into the charge influencing a recorder-controller.'

Full development

The paper goes on to describe two typical processes, full annealing—the conversion of original carbide and pearlite to ferritic iron—and normalising, and concludes 'the furnace is found to be particularly suitable for the first process described, where the evenness of heating and accurate temperature control during the critical stage of 700°C. makes possible the full development of the desired characteristics of the material.'

Although there is a good deal in common between ferrous and non-ferrous foundries there are also some very important differences. The higher cost of non-ferrous metals necessitates castings designed with thinner section, and greater care and accuracy are required in moulding and pouring. Close control over casting temperature is of paramount importance. Fluidity falls off rapidly with falling temperature and it is essential that pouring



Cast iron components of solid fuel grates being loaded into a gas-fired vitreous enamelling furnace by Ferro-enamels Ltd., installed at Richard Haightons Ltd., Burnley.

into the mould should be fairly rapid and at the same time steady, to avoid turbulence and violent spurting.

The cupola furnace already described is sometimes used for melting copper on a large scale, but it is not suitable for brass and bronze because of excessive oxidation of zinc and tin. The two main types of furnace used for melting these and other non-ferrous alloys are the pit type and the tilting type, and the three main fuels are coke, gas and fuel-oil.

The pit furnace, as the name implies, consists of a combustion chamber built in the floor and designed to accommodate a crucible usually made of plumbago. The crucible must be lifted out for pouring and for this reason it does not usually exceed 150 lb. capacity of brass, unless mechanical lifting gear is provided. With gas and oil furnaces the combustion chamber is cylindrical and the air-blast burners fire tangentially between the crucible and the furnace wall.

Maintains heat

The tilting furnace consists of a mild steel cylindrical case lined with insulating refractory bricks or a rammed refractory lining and designed to accommodate the crucible. The unit is arranged to tilt on either a central or lip axis and the crucible can be located to pour over the top of the furnace casing or through a spout lower down the furnace. The burner is usually arranged to pivot with the furnace so as to maintain metal temperature during pouring.

Although coke and fuel-oil are the choice of some foundries, mainly because of basic fuel cost, there can be no doubt that town gas has many advantages over both these fuels. The advantages over coke are, elimination of labour for stoking, removal of ash and furnace repairs, saving of fuel storage space and necessity to dry the coke. There are not so many advantages over oil but fuel delivery and storage, together with pumping and preheating, are important items. With gas the melting is rapid and the gas-air mixture can be finely adjusted to give high thermal efficiency, fine temperature control and, if required, correct atmosphere.

The melting and casting of aluminium and aluminium alloys is a science in itself and great care is needed in both operations.

For instance, aluminium absorbs hydrogen rapidly when molten and this, being released on solidification, causes a defect known as pinholing. Oxygen also combines readily with aluminium to form oxide which can be difficult to remove and is a high source of scrap. In modern practice these difficulties are overcome by degassing agents and covering fluxes.

The main source of hydrogen used to be from the products of combustion from ordinary crucible furnaces but nowadays bale out furnaces, with the products exhausted without passing over the metal, are mainly used. Gas had established itself very widely in this field, but during recent years oil, on fuel cost alone, has gained considerably. In East Lancashire oil-fired reverberatory furnaces are used for larger melts, but for high quality castings gas is preferred because of better temperature control.

The die casting of aluminium, brass, and zinc base alloys is carried out either by gravity, or pressure die-casting machines. In the gravity process it is essential that the dies are preheated before the first castings are poured. As the day or shift progresses the residual heat from the hot metal is then sufficient to ensure even casting. Gas is ideal for die heating. The burners can be fabricated to suit the contour and shape of almost any die, thus ensuring complete and even heating. A firm in East Lancashire has found that burners made from W.I. tube, suitably drilled, and supplied from a Selas gas/air mixing machine, are very satisfactory. Gas is used on pressure die-casting machines for keeping the metal in the feeder pots at the right temperature.

The heating of non-ferrous metals, and alloys is essential to render them suitable for rolling, drawing, extrusion and pressing. Temperature requirements are critical and in most cases a protective atmosphere is required. In addition to the ease of temperature control, town gas is also the natural basis for furnace atmospheres and, therefore, eminently suitable for these heat treatment processes.

So far as associated foundry practice is concerned, it is largely a question of billet heating and there are many types of furnace used for this process depending on the metal, size of billet and production requirements. Gas-fired furnaces employed on this type of work can be found in many parts of the Board's area.

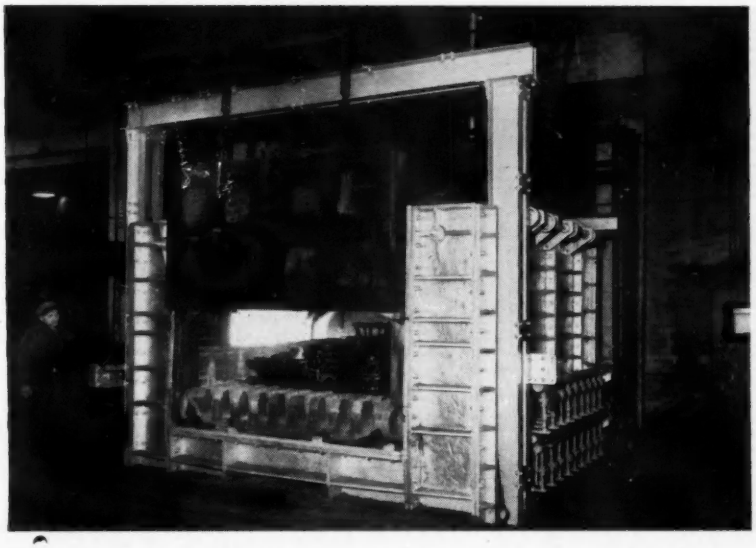
There are quite a number of foundries manufacturing domestic appliances which operate their own vitreous enamelling plant. The three main processes requiring heat in the vitreous enamelling of cast iron are as follows:

1. The vitreous enamel frit which constitutes the base of all porcelain enamel finishes is a mixture of several ingredients. In addition to considerable milling and grinding of the frit mixture it also requires melting and this is carried out in special furnaces usually of the rotary or continuous types at a temperature of approximately 1,300°C.

2. When the wet enamel has been applied to the castings, the moisture is driven off in a hot air oven usually of the recirculating and conveyor type, at a temperature of around 320°F.

3. The fusing of the enamel on to the castings is accomplished in a muffle furnace at a temperature which varies between 750°C. and 830°C. depending largely on the frit used.

Gas is a very popular fuel for these processes. Its cleanliness, easy control of temperature, minimum plant repairs and labour requirements, are



Heat treatment of steel castings in a unit by Priest's Furnaces Ltd., at Leyland Motors Ltd.

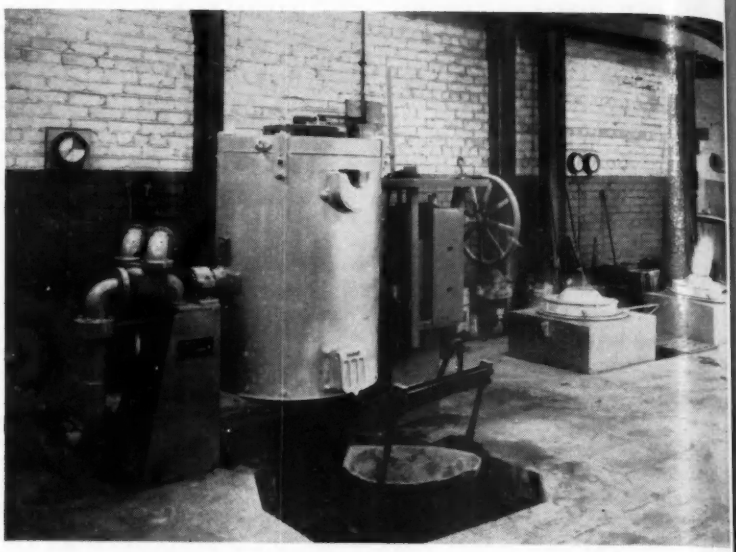
important considerations when compared with other fuels.

In addition to vitreous enamelling, a great many castings are given a lacquer or stove enamel finish. This is carried out either by dipping or spraying followed by drying and curing.

Camel-back ovens

A wide variety of gas-fired drying plant is available for these processes which include single, double, or treble-cased box ovens, the choice depending very largely on the coating applied. Camel-back ovens are now very popular where the drying plant is to be included in a continuous production line. The work is usually arranged to pass on a chain-conveyor through dipping tanks or spray booths and then without further handling, through the camel-back oven. For castings having fairly regular section, infra-red heating units are an alternative proposition worthy of consideration.

Many foundries have a maintenance workshop and this offers further scope for gas-fired plant. Pipe bending and section fabrication requires heat which can be very well provided by gas-fired units. The Liverpool Group have developed a furnace which simulates the characteristics of a blacksmith's forge. The Wirral Group have designed and fabricated table units which are eminently suitable for the rapid heating of steel section and pipe over a limited area. There is also the Thermic section-heating furnace which employs C.C. burners. Oxy-coal-gas torches and profiling machines also play an important part in foundry repair workshops for cutting and welding jobs.



A Morgan brass melting furnace, showing the 10-cwt. central axis tilting crucible and two 350-lb. lift-out crucible furnaces.

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I. G. D. C. SEE LARGE HEAT TREATMENT PLANT

THE Industrial Gas Development Committee held a meeting in June at the Scottish Gas Board's Glasgow offices. Later, they visited the works of Wm. Beardmore & Co. Ltd., Parkhead, to inspect new gas-fired heat treatment furnaces installed for the precision heat treatment of large furnaces. When the installation of the new furnace plant is completed, the plant will possibly be the largest gas-fired heat treatment assembly in Great Britain.

Members of the Committee were particularly interested in the complex instrumentation of the furnaces and the design features contributing to uniformity in temperature distribution over long heat treatment cycles.

Colonel P. M. Thomas, Managing Director, assisted by Mr. A. McNaughton, Chief Engineer, conducted the Committee through the various departments of Beardmore's and, prior to the visit, Colonel Thomas outlined to the Committee the complex control system installed for ensuring the highest quality of consistency of product. The thanks of the Committee were tendered to Colonel Thomas by Mr. R. F. Hayman, Chairman of the Committee and Industrial Gas Officer to the Gas Council.

Valuable work

Mr. H. R. Hart, Board Member, and General Manager of the Glasgow and Western Division of The Scottish Gas Board, presided at a dinner in the evening, and referred to the valuable work being carried out by the Industrial Gas Development Committee. Mr. R. F. Hayman voiced the thanks of the Committee to the Scottish Gas Board for making the arrangements for the meeting to be held in Glasgow.

Colonel P. M. Thomas, Managing Director of Wm. Beardmore & Co. Ltd., Parkhead, Glasgow explains the quality control and electronic equipment installed to allow the quick sampling of steel prior to pouring, to Mr. H. R. Hart, Mr. R. F. Hayman, Mr. A. C. Jennings, Mr. J. K. Inwald and Dr. W. A. Simmonds.

Service by West Midlands Board

(Continued from p. 175)

that these components figure largely in their work and the special requirements of nuclear power developments are also likely to be reflected in the work arriving for processing.

Extreme care is taken of all work undertaken and hardness tests are taken on Brinell, Rockweld or Vickers equipment. When necessary, complete physical tests are made on test pieces which have been heat treated with the materials concerned.

Two eight-hour shifts a day are worked for a 5½-day week and the amount of work received is sufficient to keep the staff of 25 fully employed throughout that period. The Service is now able to collect work and return it after processing or, alternatively, the customer's own transport can make use of the spacious loading and unloading bay and the mechanical handling equipment provided.

It must not be supposed, however, that the Section is solely a production unit for providing heat treatment facilities for customers, although many firms find this Service invaluable while their own heat treatment plant is being serviced, during periods when their own capacity is unable to cope with exceptional demand or, in some cases, where the volume of heat treatment work required is not sufficient to justify the installation of equipment.

Above all, the Heat Treatment Service at Adderley Street is an industrial showroom of the most practical kind where intending customers can actually see the equipment in which they are interested performing the sort of operations which it would be required to carry out in their own works. This particularly applies to new types of equipment, such as the G.A.A.-Thermic gas carburising furnace, with which many visitors will not usually be familiar.

In the West Midlands area a total load of some 164 mill. therms of gas a year is consumed by more than 10,000 different industrial users. These consumers represent a cross-section of all Britain's leading engineering industries.

DUCTAIR HEATING SYSTEM FOR COLLEGE

RADIATION'S Ductair system of warm air central heating has been installed in the new science block at Elizabeth College, Guernsey, Channel Islands.

Six gas-fired G.40 units—two for each of the three floors—have been installed to heat the laboratories, work rooms, lecture rooms and a library. Total floor area is 6,900 sq. ft.

Time switches have been fitted so that the system turns itself on each morning before classes begin. Should the night temperature drop to near freezing point, a master frost control by-passes the time switches.

The Ductair system was chosen for this building because its capital cost was comparable to the tenders received for traditional heating methods and the running costs were estimated to be lower. As the existing boiler plant in the main building of the College is already fully extended, the system has eliminated the necessity of a new boiler house.

The estimated fuel consumption is 2,100 therms per annum, assuming an eight-hour day, five days per week, for 25 weeks of the year. Cost of the installation, which was carried out by the Guernsey Gas Light Company, was approximately £1,650.

Industrial gas in an East Anglian division

—Part III

(*conclusion*)

From a paper by

R. F. SAGGERS,
M.Inst.Gas E.,
DIVISIONAL INDUSTRIAL GAS ENGINEER, IPSWICH DIVISION EASTERN GAS BOARD,

to the Eastern Junior Gas Association at Ipswich.

THE CRITTALL MANUFACTURING CO., LTD., was founded by Frances Henry Crittall in 1884. They are well known manufacturers of steel doors and window frames, but also make Venetian blinds, grain silos and greenhouses. Within Ipswich division they have factories at Braintree, Witham and Silver End, covering 24 acres, with a total of 4,000 employees. At Braintree 40,000 therms a year are used for various purposes.

Most of their galvanising is done at Witham where there are two large oil fired settings and one gas fired. This was converted from oil firing in 1955 by Crittall's staff, and contains 100 tons of spelter in a pot 10 ft. by 5 ft. by 9 ft. deep. There are 24 type 4 radiant burners disposed around the top walls of the setting, each having a maximum rating of 200 cu. ft. per hour, and six burners around the bottom, rated at 150 cu.ft. per hour each. These are built into the refractory walls 12 in. away from the pot. Gas and air are both supplied to the air blast mixers of each burner at 4 in. w.g.

An electric thermostat controls the spelter at 460°C., and another thermostat in the flueways is provided as an overheat control. Each controls a governor and solenoid valve in both gas and air supplies, and a preset bypass is connected across the two arrangements. Three preset rates of heat input are available by this set-up, a maximum of 4,700 cu.ft. per hour, a minimum of 2,400 and an intermediate setting of 3,600 cu.ft. per hour. The hot gases are led down the sides of the pot to an annular flue around its base, and pass through a stack having a contra-flow heat exchanger, which provides warm air for drying the work prior to galvanising. The setting operates 24 hours daily, excepting weekends, and normally uses 80,000 therms a year. The average consumption per ton of finished product is eight therms which compares well with installations elsewhere.

The object of using a multiple of small burners is to be able to control the heat input at any selected point. By this means control is exercised over the convection currents which exist in the liquid spelter. These are most important because they control the temperature gradient from top to bottom and thereby the evenness and thickness of coating, and also the amount of dross formation which can be a costly item of zinc wastage. It is claimed therefore that to be able to apply such small quantities of heat at selected points is an advantage which gas burners have over other fuels, both for this and another reason. Zinc has a destructive effect on iron which increases rapidly with temperature, and it is important to avoid any local overheating of a galvanising pot. If this occurs, and there is leakage it is necessary to empty the pot of the hot spelter by pump, and carry out welding repairs or complete replacement of the pot. A breakdown of this type could cost the company a possible £6,000 due to loss of zinc, loss of production, and cost of repair. If the heat input to a galvanising pot does not exceed 5,000 B.t.u. per sq. ft. at any point, this danger is minimised. Radiant gas burners can be sized, disposed, and adjusted so as not to exceed this figure. The basic principles of this method of heating have been described elsewhere.

Window frames emerging from a gas-fired galvanising bath at the factory of Crittall Manufacturing Co., Ltd.

New items

Before the existence of the East Anglian grid it was not possible to offer a supply for this setting or for the factory at Silver End. This is a self-contained village of some 500 houses and shops erected by the firm for their employees. The branch between Braintree and the grid supply was laid in 1952 and arranged to pass through Silver End where the factory and a number of houses are now connected to low pressure mains fed from a district governor. The factory had previously been self-contained, with generators, and a producer gas plant, but this has been closed, and the various die casting, sherardising, galvanising and other pieces of apparatus are now supplied with town gas. Several new items of town gas equipment have recently been installed.

These include three large degreasing tanks, each 9 ft. by 2 ft. 6 in. by 9 ft. 6 in. deep containing 1,200 gal. of liquid. Each tank is heated by two 6 in. diameter immersion tubes fired by low pressure gas burners rated at 400 cu.ft. per hour each tube. The burners were originally aerated but because of difficulty in achieving

low turn-down without light-back, we designed some simple neat gas burner heads which the company has fitted and finds to be satisfactory in every respect. The solutions are controlled at selected temperatures between 120°F. and 180°F. by rod thermostats operating relay valves and their temperature can be raised from cold to 180°F. in five to six hours. A Junopilot flame failure device is fitted for each burner.

Stoving tunnel

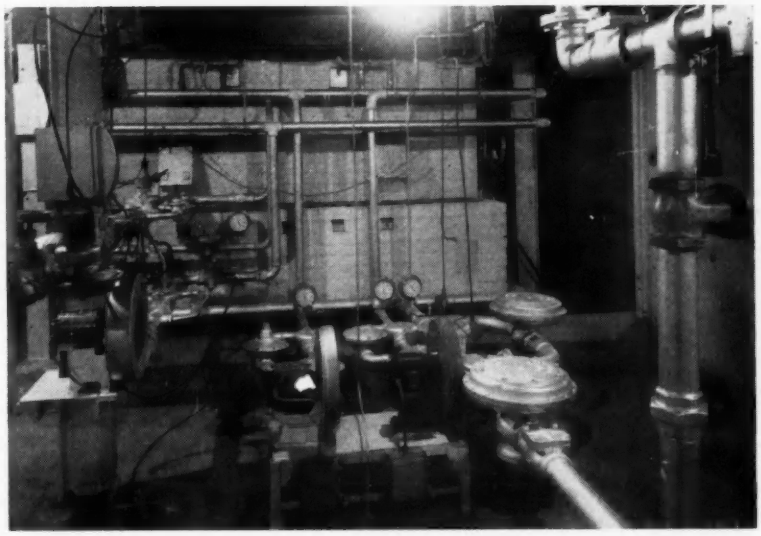
During the past year a 60 panel Parkinson & Cowan infra-red stoving tunnel has been fitted, replacing an electrically heated infra-red tunnel which could not cope with the increasing production. This is rated at 3,000 cu.ft. per hour and achieves effective stoving of steel doors and window frames in six minutes.

The overall consumption of the Silver End factory is 85,000 therms a year.

Woods of Colchester, Ltd., specialise in the manufacture of propellor and axial flow fans, ranging from 75 in. diameter axial flow types down to fans of only 2 in. diameter for electronic purposes, and for mines, ships, manufacturing processes, flour milling, grain drying, tunnel ventilation and ventilation of all classes of buildings.

The company's chief use of gas is in the aluminium foundry which produces castings from a wide range of quality of aluminium and its alloys. These are mostly melted in an oil fired reverberatory furnace from which the molten metal is carried by ladle to a battery of 20 gas fired bale-out furnaces of 200 lb. capacity each. These furnaces maintain the metal at the correct temperature for casting, and are also used for melting metals of a higher purity than could be trusted to the open flame of the oil fired furnace. High pressure gas at 5 p.s.i. is distributed from rotary compressors to tunnel burners embedded in the refractory linings of the furnaces which were constructed by Woods' own engineers. Their design was developed several years ago in consultation with the former Colchester gas undertaking and has given satisfaction ever since. The high pressure system was preferred since it was thought that airblast would be too noisy. Some work is die-cast by automatic machines while other work is hand-cast into the moulds from ladles in which case the moulds are kept at the proper temperature for casting by open flames.

The maximum gas rate in the foundry is of the order of 12,000 cu.ft. per hour, and the furnaces operate for three shifts a day.



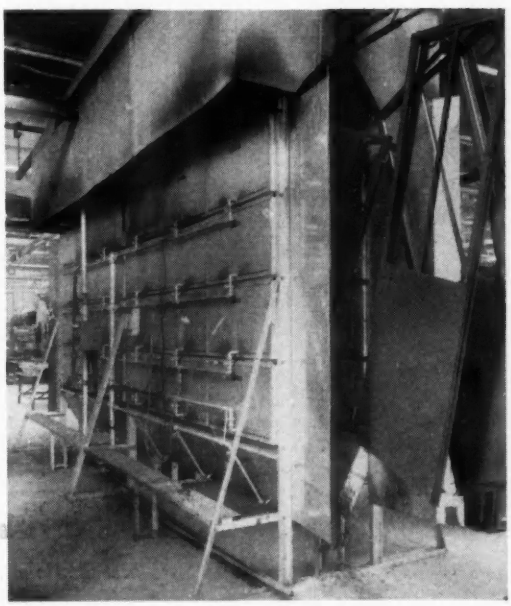
One end of the gas-fired galvanising setting in the Crittall factory.

Four degreasing tanks were recently installed for which we designed the heating equipment. Two of these are 6 ft. by 5 ft. by 3 ft. deep containing 500 gal. each, and two are 4 ft. by 2 ft. by 3 ft. deep containing 150 gal. each. They are insulated on the sides and bottom by 1 in. Marinite sheet, and are heated by 4 in. diameter immersion tubes, five for each large tank, and one for each small tank. Each tube is fired by a neat burner constructed from a mild steel head drilled with nine $\frac{3}{32}$ in. diameter holes giving 140 cu.ft. per hour. Each tank is controlled by a constant pressure governor, rod thermostat and relay valve. The contents can be raised from cold to 180°F. in four hours with a thermal efficiency of the order of 70%. Products of combustion and solution vapours are evacuated from the room by a Woods' fan.

Large boilers

The annual consumption at this factory is about 240,000 therms.

Davey, Paxman & Co., Ltd., Colchester was founded by James M. Paxman in 1865 with the object of making agricultural implements. He soon transferred his attention to boilers and steam engines, and the



A 60-panel Parkinson & Cowan infra-red paint oven at the works of Crittall Manufacturing Co., Ltd.

Woods of Colchester, Ltd. A general view of the aluminium foundry.

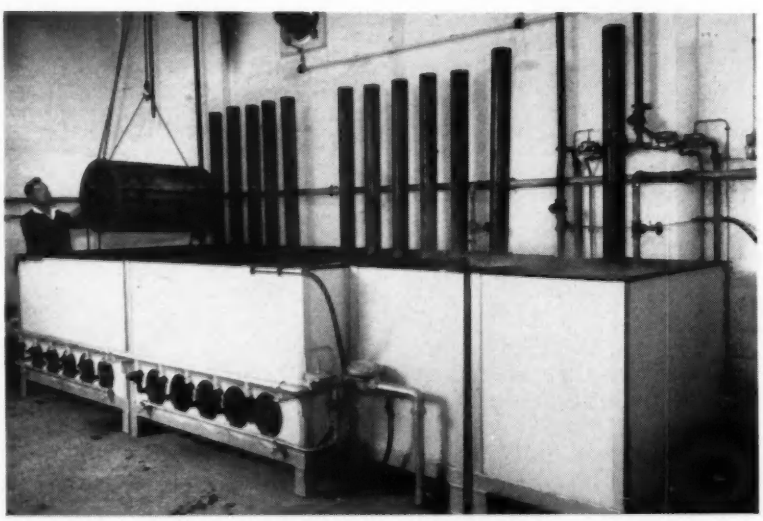
firm quickly became famous in both fields. Their Economic and Ultranomic boilers are installed at such famous London hotels as the Ritz, Savoy and Claridge's as well as many hospitals and factories. Gas engineers will be well acquainted with their waste heat boilers. Large boilers weighing between six and 40 tons bearing the notice 'This is a Paxman boiler' are a familiar sight as they wend their ponderous way through the Essex and Suffolk roads.

Since the end of World War II the factory has expanded its covered space from 175,000 sq. ft. to 360,000. The output has doubled within more recent years without considerable increase of employees. Gas has played its part in this expansion in several ways.

In the foundry a large vertical rotary core drier has been converted from coke heating by using a simple arrangement of neat gas burner, relay valve and indirect rod thermostat. This burns 1,200 cu.ft. per hour and has contributed to the improvement in working conditions. We hope to convert a similar drier in the near future. An installation of profile cutting machines mass produce components from mild and stainless steels at speeds up to 200 lin. ft. per hour. These use Ferrogas which was referred to earlier in the paper.

In the fabrication of large structures it is often an advantage, in respect of fuel usage and material handling, to be able to apply localised heating. Paxman's have found that high intensity gas burners are most suitable for such applications, and use them where possible. The heating of large diameter boiler sections prior to flanging and forming is carried out in the open by radiant heating No. 4 burners grouped around their peripheries. The burners are connected by flexible tubes to a circular manifold and are moved in and out to accommodate changes of diameter or section. They use premixed gas and air supplied from a compressor plant.

Recently we have done experimental work at Paxman's with the jet burners developed by the North Eastern Gas Board. These have proved successful and orders have been placed for a supply of a standard size, to be used for a variety of work. The first process to be put on a production basis is the heating of boiler mud-hole openings prior to flanging. A rectangular arrangement of six jet burners fires upwards to the 1 in. boiler plate and raises a 5 in. width around the opening from cold to 1,150° in five minutes. The total gas rate is 1,500 cu.ft. per hour, both gas and air being supplied at 5 p.s.i. and mixed prior to the manifold. It is intended to perform a similar operation on flue openings up to 4 ft. diameter, and also to perform progressive flanging of boiler head plates up to 13 ft. diameter.



Degreasing tanks, lagged with 1-in. Marinite, showing the immersion gas heaters.

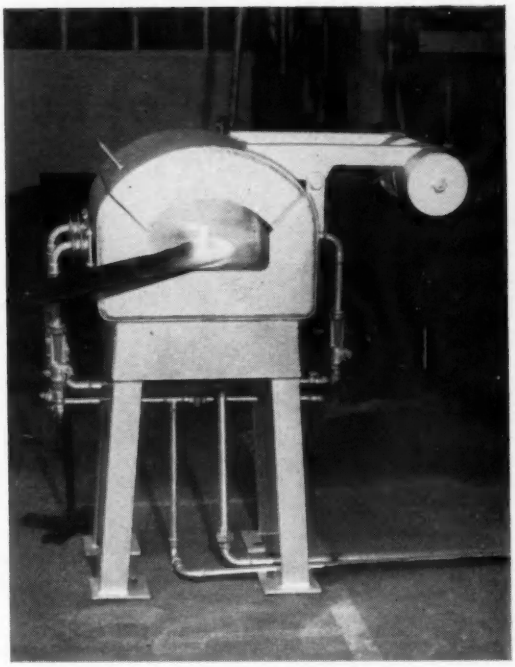
Electronic control

A large amount of fabrication work is heat treated in a Dowson and Mason gas-fired stress relieving furnace. This has inside dimensions of 10 ft. 6 in. wide by 10 ft. 4½ in. high, with a bogie hearth 28 ft. long. The bogie will take a load of 45 tons and runs on rails for a total length of 64 ft., *i.e.*, 33 ft. beyond the furnace door. 24 air-blast burners with a total rating of 10,800 cu.ft. per hour fire at hearth level between the piers and directly beneath the furnace arch, and are positioned so as to avoid flame impingement. An air failure device prevents gas passing to the burners unless air for combustion is available from the fan. Electronic control is fitted incorporating programme control of the heating, soaking and cooling sequences. A permanent graph showing the time and temperature cycle for each load is recorded for reference.

There are many other items of gas-

fired equipment and the total metering capacity amounts to 66,000 cu.ft. per hour.

What has been described is a cross-section of industry, using only a few of the 4,000 processes in which town gas is known to be used. Even this small number possesses a complexity of burners and controls, and it is generally agreed by many leading personalities in the gas industry that industrial customers require specialist service from full time industrial engineers/officers/representatives with easy access to development facilities. As I see it, the industrial man has three main functions: (1) The development of gas sales; (2) to assist the industrialist in his production methods and so increase his productivity; (3) to assist the development centres and his counterparts elsewhere in the country in solving process problems. He can only perform these duties properly by spending the majority of his time 'on the factory floor.'



Gas-fired furnace for heating angle and other sections prior to bending at the works of Davey, Paxman & Co., Ltd.

DISCUSSION

Mr. A. H. Bird, Tottenham Division, Eastern Gas Board, said: An attractive feature of this paper is the perspective which Mr. Saggers has created by presenting his subject against a background of historical allusion, biographical anecdote and interesting facts of a general kind about the processes themselves. I think this method of presentation is a good one, for two reasons.

First, it is an author's plain duty to make his subject intelligible and interesting to the whole of his audience, and that is not so easy with a specialist subject. I believe you will agree that Mr. Saggers has admirably acquitted himself on this score.

Secondly, this treatment is a reminder to all of us whose life's work is in the industrial gas field to straighten our backs from time to time and take a good look round.

Indeed, it is highly desirable that an industrial gas engineer should take this wider view, for an appreciation of local traditions and sentiments is of considerable help in making the best approach and maintaining the ideal relations with his customers.

An aspect of this paper which may surprise readers not familiar with East Anglia is the amount and diversity of industry that exists here.

To many the word 'industry' still conjures up a mental image of a grimy town of ugly little brick houses, huddled round a dark satanic mill somewhere in the smoky north.

Actually there is an industrial revolution going on before our eyes which has considerable significance for us in the Eastern Gas Board. I refer to the dispersal and re-distribution of industry.

Many present-day manufacturing processes are quite independent of specific geographical conditions.

The location of a new factory is now often decided by the existence of a suitable labour force, cheap land and rates. Of course easy access to raw materials and to the principal markets is important if the goods are bulky or very heavy.

A new factor in the re-shaping of the economic life of the northern part of East Anglia is the Government's Distribution of Industry (Industrial Finance) Act, 1958, and the London overspill projects.

One is occasionally intrigued to find that an element of personal preference has also influenced a decision on factory location. A manufacturer may well choose to live his life and raise his family in the more wholesome atmosphere of a country town than in monotonous suburbia.

Better position

On all these accounts East Anglia, and I would say much of the Eastern Gas Board's area, has attractions for industrialists, and we are in a better position than ever before to supply the heat requirements of any potential customers.

But, as Mr. Saggers plainly knows, we can reap a harvest in these fields only if we can get into them to sow the seeds at a very early date. A few days delay in meeting the right people might mean decisions have been made which would preclude us from benefit for a decade or more.

Even in a compact industrial area it is not easy to get wind of factory development at the right time; out here in these relatively small and scattered towns it must be hard for one man to cope with the problem without the fullest co-operation of his colleagues in other departments, who are in touch with local affairs and personalities.

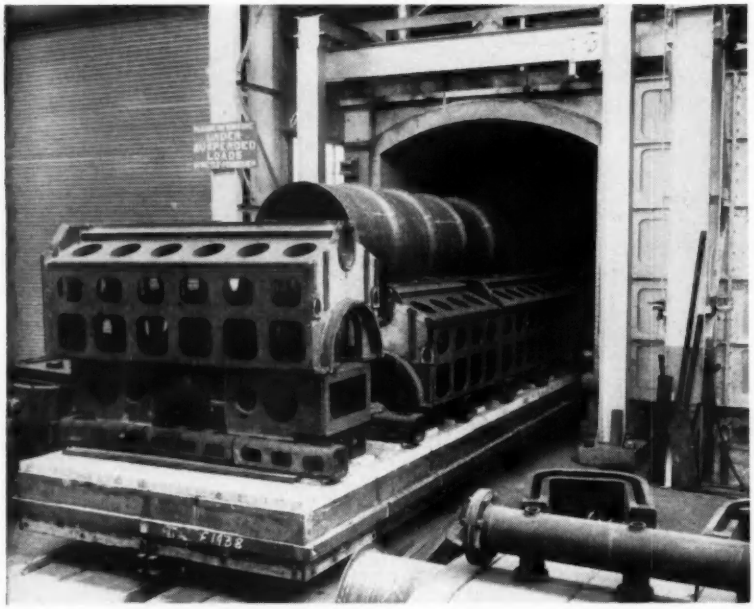
Fruitful co-operation

Viewed from outside the division the expansion of industrial gas sales here suggests a very fruitful co-operation between Mr. Saggers and his colleagues.

It would be interesting to hear how the Bury St. Edmunds and the Haverhill developments are progressing and how the problem of making contact with potential tenants at the right time is being tackled. I understand that the London County Council is largely responsible for promoting these estates and suppose it is therefore rather difficult to maintain an adequate liaison with them and emigrant firms in the London area.

Turning to technical matters, there are a good many things touched on by the author which excite curiosity.

Referring to [p. 3] could you say whether the pre-mixed gas and air is a complete stoichiometric mixture and explosive in character? If so, what safety devices are used? Have there been any back-fires? I am particularly



Another picture taken at the works of Davey, Paxman. Shown is a gas-fired stress relieving furnace, with a capacity of 10 ft. by 10 ft. by 28 ft.

interested in this because pre-mix is under discussion with your old friends, Messrs. Hawley Products.

For another reason I should be glad to know more about the ignition and control of the singeing flames. How is under or over-heating prevented when the machine is starting and working up to normal speed or when it is slowing down? And what happens when there is a sudden accidental stoppage?

When reading the table of bread baking consumptions on [p. 9] I couldn't help wondering how many bakeries there are in divisions other than my own using gas ovens for confectionery baking only and therefore not enjoying the Tariff 6 and consequently excluded from the table. We have a number of the Tottenham division. Are there any in the Ipswich division?

Mr. Saggers, replying to Mr Bird, said that as far as overspill was concerned, there was some difficulty in contacting prospective tenants. There was, he said, a cloud of secrecy as to which manufacturer was to have what sites, and when. Development had not gone very far, although two factories had been built in the area. The authorities at Bury St. Edmunds had tried to encourage the use of trading estates, but he (Mr. Saggers) had not heard of anyone taking up sites. Answering Mr. Bird's safety query, Mr. Saggers said that the mixture was explosive and safety measures, flame traps, etc., were incorporated in the Holmes-Kemp equipment used. Everything was controlled manually, and he had not heard of any mishaps with the equipment. Mr. Saggers said, in reply to another query from Mr. Bird, that as far as he could see, no confectionery baker was being supplied with gas under the bread baking tariff.

Mr W. F. Pritchard, President, said that the Eastern Gas Board had trained quite a few industrial engineers since nationalisation. He suggested that it would be a good thing for prospective industrial engineers to become connected with such bodies as the Institute of Fuel and the Institute of Heating and Ventilating Engineers.

Mr. Saggers replied that prospective industrial engineers should have a good general gasworks background. Another institution which they may attempt membership of was the Institute of Production Engineers. He said that one or two manufacturers had made some facilities available for the training of industrial engineers, and mentioned the question of adaptability.

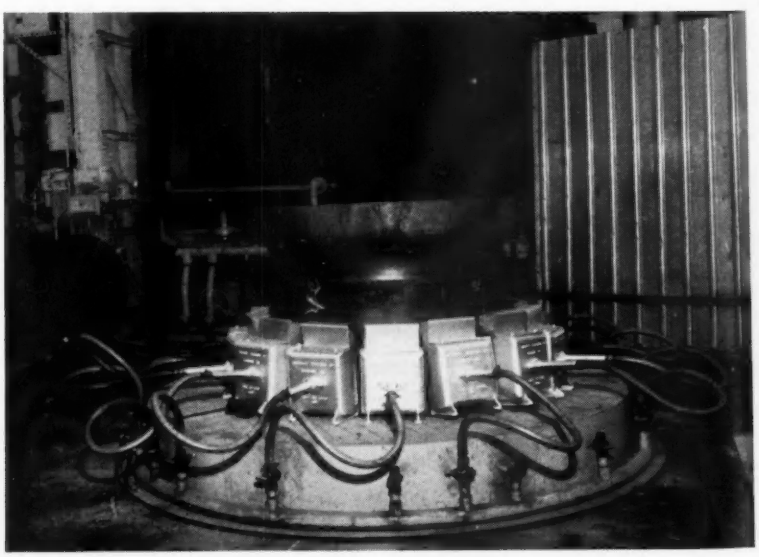
Mr. C. Moore, Watford Division, Eastern Gas Board, said that industrial engineers liked to hear what others in this field had done. He was aware of the great shortage of engineers on the industrial side of the industry.

Mr. Saggers, replying, mentioned the 'pilfering' of industrial engineers from the industry to outside concerns.

Mr. R. S. Falkner, Ipswich Division, Eastern Gas Board, said that his had always been a de-centralised division, and he had never regretted Mr. Saggers joining it. Mr. Saggers, he said, had no staff. There was a good reporting system in the division whereby information relating to new trade coming into the area was assimilated and dealt with.

Mr. T. W. Benstead, Clacton District, Ipswich Division, Eastern Gas Board, said he thought there was a need for an industrial centre in this area, catering for industry in East Anglia. He mentioned the value of demonstrations to traders by industrial engineers.

Mr. R. L. Smith, Colchester District, Eastern Gas Board, proposed a vote of thanks.



Pictured is a gas-fired furnace for locally heating boiler furnace sections prior to flanging at the works of Davey, Paxman.

Agriculture

Hagrane dual-purpose drier fired by gas or coke

THE gas industry's latest contribution to agricultural development is a new dual-purpose barn-hay and grain drier—the Hagrane. It utilises an alternating air flow between twin trays or bays; cool air is drawn down through one tray, heated, and blown up through the other tray, this process being reversed periodically.

Eight-ton hay batches

The Hagrane is designed to dry a maximum of eight-ton batches of hay in medium density bales, and to dry corn in three-ton batches at the rate of two tons per hour, standard moisture extraction rate.

Hay drying. Both bays are loaded to a depth of approximately 7 ft. with medium density bales and drying commences by blowing hot air at 150°F. through the first bay loaded. The other bay, through which the cold air is being drawn, is then loaded with a similar quantity of bales and after a period pre-set by time switch the air flow reverses, drawing cold air down through the heated hay and blowing hot air up through the cool hay.

Corn drying. Sides are fitted to the metal drying floor of both bays which will each accommodate about three tons of corn. Drying commences by blowing heated air through one tray and cold air downwards through the other; this continues until the first tray is dried. The air flow is then reversed and hot air is blown through the tray which has been ventilated with cold air; after the first tray is sufficiently cooled a hydraulic ram tilts the tray to the centre of the drier where the grain flows down on to a chain and flight conveyor which carries it to the elevator. The tray is restored to its horizontal position and can be refilled with wet grain. After the second tray is dried the procedure is repeated.

Hydraulic lifter gear

The drier metal work consists of perforated metal drying floors with removable tray sides and hydraulic lifter gear. The heating system is a semi-producer type furnace which may be fired by gas or coke, incorporated in a four-way duct system with a motor-operated rotating damper controlled from a time switch. The drier chambers consist of a solid platform constructed either of concrete blocks or bricks, with 8 ft. high sides above the platform for accommodating the baled hay. The wall can be either a continuation in brickwork, concrete blocks, sheet steel, or any other suitable material, its purpose being simply to enclose the hay bales while drying.

Institute Co-operates

The National Institute of Agricultural Engineering at Silsoe are co-operating in the development of this drier and have installed a unit for testing.

FOOTNOTE: It is stressed that the quantities for drying given above are not yet confirmed by test.

FOR FARMERS WHO NEED A GENERAL PURPOSE UNIT

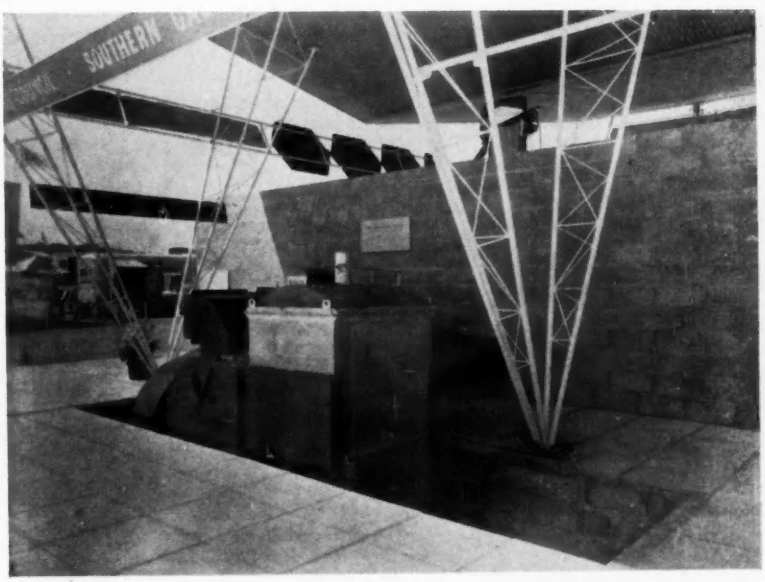
THROUGHOUT the Royal Highland Show at Aberdeen last month, a demonstration of grain drying was given by a new type of coke-fired furnace, the Beverley A, manufactured by D. Clark & Company of Hull. This had been designed for farmers who need a general purpose unit for batch or bin driers.

One unit

The furnace and air mixing and temperature control chamber are constructed as one unit; a removable hopper is mounted over the furnace. This hopper is designed to give a running time of about six hours at full output and the heater unit is useful on platform or batch driers having a required output of ten cwt. of grain per hour, or on small bin driers.

In the Gas Council Pavilion photographs showed the uses of gas in Scotland and pointed out the benefits of ammoniacal liquor. a valuable fertiliser.

The gas and coke appliances displayed on the stand showed the versatility of the two fuels.



The new Hagrane dual purpose barn-hay and grain drier. It utilises an alternating air flow between twin trays or bays—cool air is drawn down through one tray, heated, and blown up through the other tray, this process being reversed periodically. This photograph was taken at the Gas Pavilion at the 1959 Royal Show at Oxford.

For reliability, convenience and simple costing—

This diecasting firm finds gas the most suitable of all fuels

A DIECASTING firm which was formed in 1945, with a small factory and a labour strength of six, now has 120 employees working in a factory of 20,000 sq. ft. The growth of the firm reflects the growth of the diecasting industry in Britain since the pre-war years. For example, the firm—T.A.L. Developments Ltd.—has increased its turnover almost threefold in the last five years.

It was the war that set the wheels in motion for a vast expansion in diecasting in Britain; a substitute was needed for machined components in order to step-up production, and diecasting was the answer. Before the war, diecasting had not reached the importance in this country that it now enjoys, because large users outside the motor industry were the exception rather than the rule. Wartime development changed all that, and today there is variety in plenty at the T.A.L. works at Tottenham.

Avoiding rejects

Among the larger zinc-base pressure diecast components made there are headlamp bezels for the Ford Motor Company; these are of a complicated design and have eventually to be chromium plated. To avoid rejects, it is essential that the surface quality of the discastings is of a very high order. Carburetter parts afford examples of a complex discasting technique where the diecasting process has minimised machining and drilling costs to a considerable extent.

At the other end of the scale, there are ladies' watch cases, diecast and weighing only a few grams. Among other items are gold plated zinc base diecastings for electric shavers, components for the electrical and radio industries, and washing machine components.

Some of the diecasting machines have been bought complete, but what is of extreme interest are those machines which have been built by the firm themselves for their own use to meet special conditions of different contracts.

The diecasting process is well-known. The zinc base alloy is melted in a furnace and the molten metal is pumped under high pressure into a steel die which forms the component to the shape of the die. Air valves open and close the die while operating the pump in a sequence so that the whole process takes place on a controlled temperature/time schedule. Such machines are built for relatively large, complicated diecastings.

On the other hand, when it comes to long runs of relatively small diecastings a nearer approach to automation is required. The firm decided to build a number of completely automatic machines.

They designed an electronic timer which, by operating the air valves, automatically opened the die, closed it, allowed molten metal to flow into it, then opened it and ejected the casting without any action by the operator, while a counting mechanism on the electronic timer told the operative precisely how many components had been turned out.

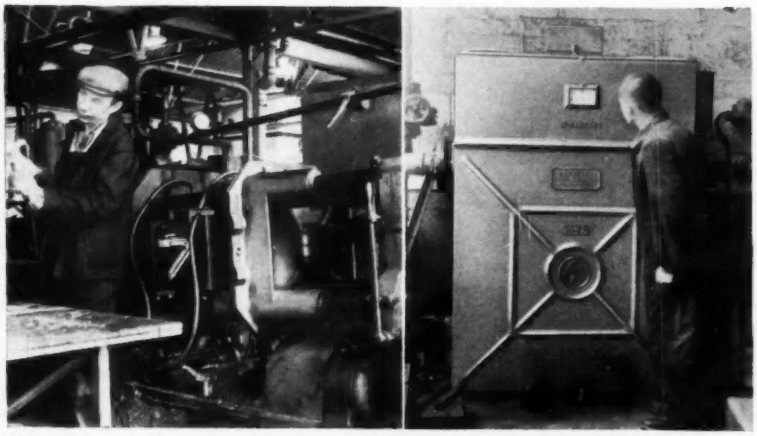
The firm believes that gas is the most suitable fuel for diecasting—first because of its convenience and second because of its reliability. 'It also means that we have the simplest form of costing,' pointed out Mr. M. C. Aldridge, who is one of the three partners who started the business, and is now Secretary and Director. 'The meter reading is there for us to see day by day, and we can keep a close check on the fuel cost per unit of output. And, of course, we know monthly or weekly fuel figures without having to attempt to determine how much solid fuel there is in a heap in the yard, or how much liquid fuel there is in a tank.'

It is, of course, important that all the liquid metal in the diecasting machines be maintained at a controlled temperature. A thermocouple in a protective sheath is located in the chamber containing the molten metal; this thermocouple sends a signal to the control pyrometer, which is pre-set to the desired temperature. As the temperatures approaches the set point, the pyrometer automatically activates a solenoid valve, so cutting down the gas to maintain the correct temperature.

Temperature maintained

'Town gas is, therefore, an ideal fuel for this process because it has a constant calorific value and is supplied at a governed pressure so that the temperature control is very easily maintained. In addition, of course, there are no fuel deliveries, no wasted storage space, and it is the easiest fuel for the operatives to work with,' said Mr. G. A. Logan, another of the partners, who runs the production side of the factory.

The firm not only specialises in zinc base diecastings; it also makes considerable quantities of pressure aluminium alloy castings. The process here is somewhat different. The aluminium alloy is separately heated by gas in non-metallic crucibles, again on pyrometer control principles, and is ladled in the molten state into the diecasting machines.



On the left is a view of a diecasting machine open, showing the die. A giant gas meter, illustrating how town gas affords simple fuel costing, is on the right.

Giant spray booths equipped with gas

TWO gas-heated paint spray and drying booths at the Tyburn Road works of Birmingham City Transport Department are each big enough to accommodate a double decker omnibus 30 ft. long, 8 ft. wide and 14½ ft. high.

They were installed when the Department changed from brush to spray painting as a more efficient and economical means of painting its buses within a maximum interval of 2½ years. Previously tests over several years had shown that sprayed varnish, properly applied, would stand up to service as well as paint, brush-applied by experienced coach painters.

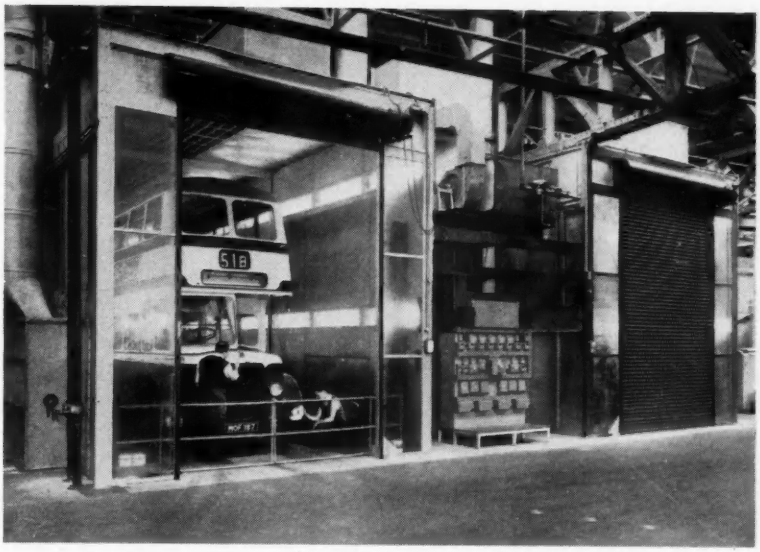
The booths are of the water wash down draught type each being 36 ft. long, 16 ft. wide and 18 ft. high. The entrance to each can be closed with power operated roller shutter doors. Each booth is equipped with a moving gantry which rises 11 ft. above ground level around the vehicle to be painted.

After a bus has been driven into a booth and sprayed, the roller shutter door is closed and gas heated air is blown into the booth to dry the paint.

The air intake is through a louvred ducting in the outside wall of the paint shop and this duct is coupled to an air filter unit. To heat air taken into the booth an auxiliary hot air fan draws air from the shop through a direct fired gas heater into a mixing chamber in each booth. The gas heated combustion chamber is fabricated from mild steel plate and lined with refractory brickwork. The burner is of luminous pattern and has a thermostatic control system. A fan failure protection switch automatically turns off the gas when the fan ceases to operate.

Safety aids

The gantry can be operated only from inside a booth. An interlock prevents the gantry rising if the gantry safety gates or roller shutters are not closed. Another interlock prevents the roller shutters operating if the gantry is not at ground level.



The spray booths at the Tyburn Road works of Birmingham City Transport Department. Each is big enough to accommodate a double decker omnibus, 30 ft. long, 8 ft. wide and 14½ ft. high. They were installed when the department changed from brush to spray painting as a more efficient and economical means of painting its buses with a maximum interval of 2½ years.

FIVE SECONDS TO SERVE A MEAL IN NEW STAFF RESTAURANT

RESULTING from a simple enquiry for advice on gas-heated catering equipment, the Manchester Group of the North Western Gas Board recently obtained an order for a complete kitchen for a staff restaurant to serve 500 to 600 people.

The complete scheme was designed in close co-operation with the firm concerned, and the plans submitted by the Group Commercial Section covered both kitchen and dining room layout.

Appliances supplied and installed include Stratford ovens on stands, a double-compartment Keswick steamer, a Stratford boiling table and a Savoy griller, all made by Radiation Group Sales Ltd. Three deep fryers made by Stotts of Oldham were also installed.

Hot water for sinks and a dish-washer was provided by the installation of a Potterton Rex 150-gal. storage set.

The gas-heated dish-washer and other labour-saving machinery were by the Hobart Manufacturing Co. Ltd., and the island ventilation canopy was by Ezra Hatton & Company of Manchester.

The most striking feature of the installation was the special purpose made service counter with tray rail. This comprised 24 ft. of hot section with a bain marie top and 21 ft. of cold section, with cashier's section incorporated. The counter, with a stainless steel top, was made by Radiation and incorporated a Stott Connoisseur cafe set for tea and coffee service.

The dining room seats over 300 people, and at present 200 to 250 meals are served at each of two sittings.

Meal service is by self-help from the cafeteria service counter, and so speedy is the kitchen staff that 200 meals are served in 15 minutes at each sitting—less than five seconds per meal.

Personal interest

The company which placed the order for this attractive and streamlined modern staff restaurant is S. Miller (Manchester) Ltd.

The new kitchen and dining room also serves the firm's mail order branch.

Mr. C. B. Stockton, a director of the company, has taken a personal interest in the new kitchen and has helped the Manchester Group's draughtsmen, sales personnel and technicians to achieve the final happy result of completing one of the most attractive and modern staff restaurants in Manchester.

East and West provide Midlands stand

FOUNDRY EXHIBITION IN BIRMINGHAM

VISITORS to the foundry exhibition held in Birmingham recently were able to obtain on the spot information about the comprehensive fuel service offered by the gas industry at an information room sponsored jointly by the East and West Midlands Gas Boards. The room was staffed by qualified fuel technologists, able to deal with individual enquiries from industrial consumers of gas and, in particular, questions relating to the use of gas in foundries.

Information service

Arrangements had also been made for the answers to information sought to be sent, if so required, direct to Board officers serving the district in which the enquirer's works were situated.

Bale-out furnace

On show was a prototype 300-lb. bale-out furnace for diecasting shops designed by engineers of the West Midlands Gas Board Industrial Department for the non-ferrous industry. It incorporated recuperation of hot flue gases. The fan, motor and controls were integral with the setting. The plant had been designed to give the best possible working conditions for operatives.

A series of exhibits and photographs illustrated the big part gas plays in the industrial field. They include, for example, a model of the Britannia airliner, castings which are components of this aeroplane; a group of sand cores used in the production of iron castings; and actual castings malleablised in a gas-fired continuous tunnel furnace.

A prototype bale-out furnace and a model of the jet aircraft, Britannia, with references to the part played by gas in its production, were features of the joint East and West Midlands Gas Boards' stand at the foundry exhibition.

This jet burner fabricated at the Industrial Department Headquarters of the West Midlands Gas Board for a consumer has a slot measuring 24 in. by 3½ in. and was developed for the lap welding of tubes 18 in. to 24 in. diameter manufactured from mild steel plate ¼ in. to ⅝ in. thick. The gas consumption is approximately 6,000 cu.ft. per hour at normal mains pressure and air is supplied at a pressure of approximately 30 in. w.g. The velocity of the products of combustion at the exit to the burner are in the order of 280 miles per hour, and the plate is raised to a temperature of 1,450°C. prior to welding.

HOSTELLERS' FOOD COOKED BY GAS

THE Queen, accompanied by the Duke of Edinburgh, has inaugurated the largest hostel in the Youth Hostels' Association—Holland House in Holland Park, Kensington.

Once the stately home of the Earls of Ilchester, Holland House was badly damaged by bombs 15 years ago. The building has been restored.

Self-catering

Meals are cooked for hostellers in a central kitchen, but, as in all hostels, there is a kitchen where members who prefer it may cook their own food. In conjunction with the North Thames Gas Board, the authorities have had installed a double oven cooker, griller, cafe boiler, steamer, dual-purpose boiler, incinerator and a gas-heated service counter. For the 'self-caterers,' there have also been fitted ten Main rangeplates.

Each year between 30,000 and 40,000 young people will use this hostel and the facilities provided.